Department of Scientific and Industrial Research

Productivity in Letterpress Printing

London:
Her Majesty's Stationery Office
1961

Set in Monotype 'Joanna' series

Preface

THIS study of productivity in letterpress printing was carried out by the Printing, Packaging and Allied Trades Research Association under a contract from the Department of Scientific and Industrial Research. This contract was placed with a view to determining what steps can be taken to increase productivity of this process, and was financed by a grant from Counterpart Funds derived from United States Economic Aid under Section 9 (c) of the Mutual Security Act of 1952.

The report is the result of an investigation by a working group between December, 1956, and November, 1958. It was carried out under the direction of Mr A. Lord, the other members being Mr R. C. Blakey and Mr J. Elphick.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
State House, High Holborn, London W.C.1
August 1961

Contents

Introduction

THIS report summarizes the results of a two-year investigation (commenced in 1957) into productivity in flatbed letterpress printing. Because of the individualistic nature of printing firms it is seldom possible to propose a single solution to problems common to many firms. It is, on the other hand, possible to define, as we have done in this report, those general factors which have an adverse effect on productivity and at the same time to provide sufficient detail to encourage firms (perhaps with outside assistance) to examine these factors for themselves. It will be easy for individual managers to say 'we don't have this problem' or 'we know about this one', but the experience of the investigators is that such statements are often incorrect. This is so because the managers generally have insufficient information presented to them. Even when the problems are known, their full effect on cost, output, and on subsequent stages of the process is not fully realized and requires detailed study.

The report is divided up into Parts, which can be read independently, each roughly corresponding to one of the original aims of the investigation. Each Part has an introduction and each main section an introductory summary in order to facilitate a quick reading and the selection of those sections of specific interest to the reader. The Parts of the report are as follows:

Part I. The background and scope of the investigation.

Part II. The measurement of productivity and factors influencing it.

Part III. Detailed examination of the machine room with special reference to the effect of different methods on the utilization of machine time.

Part IV. Brief consideration of other departments and the main problems occurring in these.

Part V. Outstanding problems calling for further study in individual firms and by organizations such as The Printing, Packaging and Allied Trades' Research Association (PATRA).

Part VI. Summary of report.

Appendix A. Information related to productivity measurement.

Appendix B. Explanations of certain scientific terminology.

Part I. The Investigation

1. ORIGIN

As part of the general aim of the Department of Scientific and Industrial Research to further research in industry it awarded a contract to The Printing, Packaging and Allied Trades Research Association (PATRA) to study productivity in flatbed letterpress printing. The need for such an investigation had been expressed at the PATRA Letterpress Methods Conference at Eastbourne in 1955.

2. OBJECTS

The four objects in view when the investigation was commenced were:

(i) to determine whether operational research techniques could be of value to essentially craft industries;
(ii) to measure the variations in productivity in flatbed letterpress printing and to investigate the causes of these variations;
(iii) to examine inter-relations between departments within a firm, and between firms within an industry; and
(iv) to assist in the formulation of PATRA's research programme by identifying the main technological problems.

3. SCOPE

The contract was for two years ending in November 1958 and three investigators were employed. While it was not expected that such a general survey would allow any use of sophisticated operational research techniques, the general approach was of an operational research nature.

Preliminary visits were made to some thirty firms, many of which had previously indicated their willingness to co-operate in response to a questionnaire survey. All of these were members of PATRA. Marked differences between firms became apparent in the course of these visits and it was therefore decided that the investigation would be of greatest benefit to the industry if the range of differences covered was fairly wide. This was preferred to the alternative approach of examining at length one or two firms hoping that the conclusions drawn might be relevant to others. Early studies were however con-

 centrated on firms producing mostly bookwork as it was felt that

constancy in the type of work might facilitate comparisons. The seventeen firms eventually studied in detail were chosen so that they included many characteristics such as large and small numbers of employees, high and low proportions of book and colour work, with and without bonus incentive schemes, and so on. Their characterization in these terms is as follows:

Bookwork	No. of firms	Personnel	No. of firms	Incentive scheme	No. of firms	Process colour work	No. of firms
Below 25%	6	120–300	8	No	8	Very little	9
25–75%	5	300–600	3				
Above 75%	6	600–1500	6	Yes	9	Considerable	8

Furthermore, these firms were situated in different parts of Britain. While this classification is not claimed to be representative of the industry as a whole, the coverage should be sufficiently wide to be of value to a large section of it.

The investigation was first discussed with secretaries or their representatives of the appropriate trade unions; these, together with several master printers and a representative from the Department of Scientific and Industrial Research, formed an Advisory Panel. The forming of this Panel was important but reduced the effective time for detailed studies to eighteen months owing to the difficulty in getting panel members together at any one time. Co-operation of individual Chapels at the firms studied was also important to the success of the investigation; this co-operation was readily given on the understanding that the investigation was confined to the study of machines, methods and organization, rather than individuals. In these circumstances information on labour productivity was not sought nor could any effects on machine productivity of industrial arrangements on matters such as machine speeds be investigated. As the latter affect all firms to a greater or lesser extent, they do not invalidate the conclusions of this study.

Part II. Productivity Measurement

1. INTRODUCTION

Often the most economic way to increase production is to increase efficiency. This may appear obvious but at the same time surprisingly few firms are making any notable efforts in this direction. It was therefore a main object of this investigation of flatbed letterpress printing to measure productivity and by demonstrating the scope for improvement to provide some impetus to action by printers. Clearly a satisfactory measure would show also what were the important factors that influence productivity and so enable efforts to improve efficiency to be best directed.

It was decided at the outset of the investigation that production would be measured in terms of physical output rather than cost. In a largely bespoke industry which claims that no two jobs are the same, there are very real difficulties in both methods. In the first place there is no single product which is common to all the departments in the firm and so the ideal approach to measuring the productivity of a firm would be to measure productivity in each department separately and to combine these measurements in some way. The next difficulty is how to measure the efficiency of some departments; for example, in the composing room, how to compare the efficiency in making up a page of straightforward matter with that in making-up mathematical text. Lack of information about production, however, is the real problem. Appendix A gives a list of information which was collected, whenever possible, in order to make as many comparisons of efficiency as possible, but a great deal of it relating to departments is so scant as to be of little value to this end. It is admitted that the reason for this is that much of the information is of little interest to the printer in the daily running of his business. On the other hand there were firms who had a great deal of information available, but most of these made very little use of it. The one measure of production which it was possible to extract for all firms was the number of impressions produced in a period.

'Impressions produced' was, therefore, used as the basis for comparing efficiency of firms. The use of this single measure is a limitation of the original intention, but as far as a firm's production is concerned the machine room is the most important department; increased production here allows an increase in production in all other depart-

ments to fill the extra machine room capacity. Finally it might be expected, since efficiency is largely the result of efforts by senior management, that a firm which is efficient in one department would be similarly efficient in others (although in the actual investigation notable exceptions to this rule were met).

2. INDICES OF PRODUCTION

Summary

Various indices of machine production are considered based on number of impressions produced. The most satisfactory is one which takes account of several factors. There are some factors which cannot be measured objectively, such as type of work and quality, and so the index is still not a complete account of machine production.

In industries which produce a standard product it is justifiable to measure productivity in such terms as output of product per man hour or machine hour. Using impressions as the unit of production the same ratios could also be determined, i.e. impressions per man hour and impressions per machine hour. These two ratios are given for sixteen firms, denoted by letters of the alphabet, in Figs. II.1 and II.2 respectively.

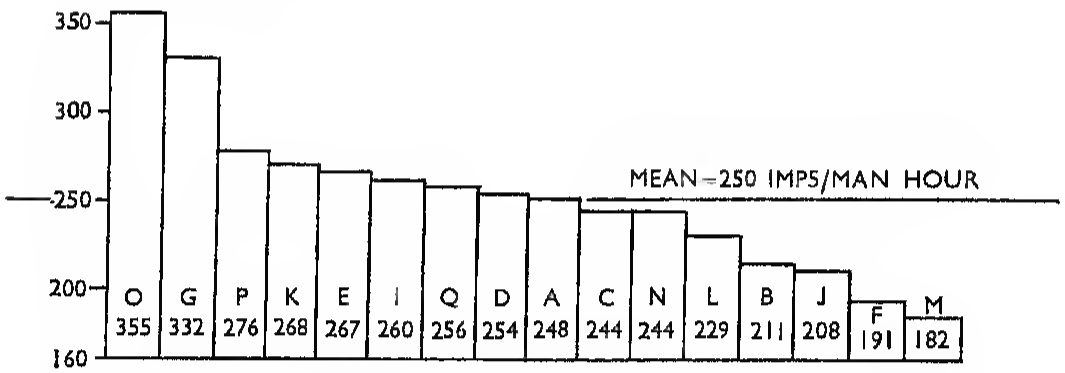

Fig. II.1. Impressions per man hour

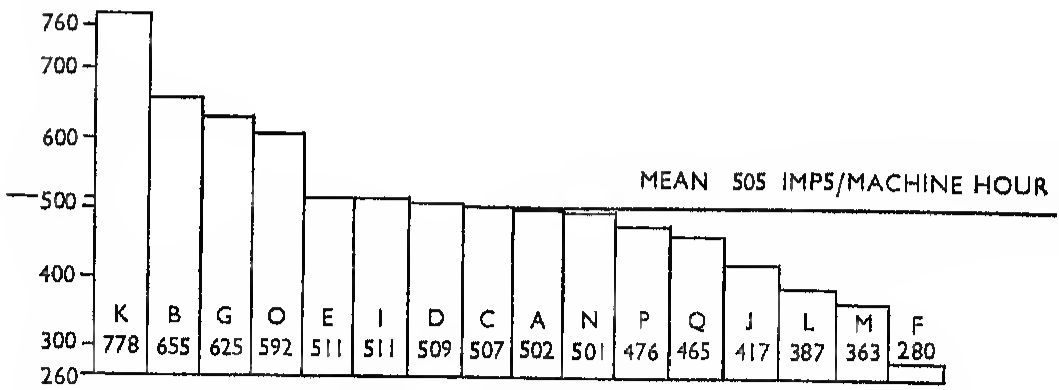

Fig. II.2. Impressions per machine hour

Such indices are of limited value to an industry such as printing since they only take account of a single factor when there are several others which may influence the number of impressions produced. Furthermore, such indices are unduly affected by these other factors, for example, by running speed.

To overcome the defects of these ratios some index must be constructed which will allow several factors to be used at the same time. This can be done if a technique known as multiple regression analysis is used (see also Appendix B). The basis of this technique is simple enough. If for several firms the number of impressions produced in a standard period is plotted against the number of machine hours taken, the points are found to lie roughly on a straight line. It is possible to calculate a line which will best fit all the points. This may be viewed as the line the average firm would fall on and may be expressed by the usual equation for a straight line, which is

$$Y = a + bX$$

where Y = number of impressions produced
X = number of machine hours

and a and b are constants determining position and slope of line.

Knowing then the number of machine hours taken, it is now possible to calculate the number of impressions the average firm would produce. If in practice a firm produced more impressions than were calculated it would be better than average, likewise if it produced fewer it would be worse than average. The accuracy of the position of the line may also be calculated as well as the significance of the implied relationship between the quantities plotted.

In much the same way an equation can be found which takes several factors into account, though it is no longer possible to illustrate it by a straight line since it will have several dimensions. The equation is now fitting the best surface described by these variables and as before it is possible to test whether any particular variable is having a significant influence on the number of impressions produced. In devising an index for printing production eleven factors were examined in order to test their importance. These are:

TOTAL HOURS THE MACHINE IS MANNED TO PRODUCE THE NUMBER OF IMPRESSIONS
NUMBER OF MACHINES
MAXIMUM SHEET SIZES OF MACHINES
NUMBER OF OPERATIVES IN THE MACHINE ROOM

Number of semi-skilled operatives in the machine room
Number of supervisory staff in machine room
Number of skilled compositors in the firm
Number of forme changes in period considered
Gross output (in £) of the firm in the period
Horse-power of machinery in the machine room
Electricity consumption of the firm in the period

Only the first four of these factors were found to be significant.

Using these four factors, the expression for the best fitting surface, which gives the number of impressions the average firm would produce, is

$$Y = 415X_1 + 246X_2 - 147X_3 + 126X_4 - 88$$

where Y = thousands of impressions.

X_1 = thousands of machine hours worked.

X_2 = number of machines.

X_3 = total maximum sheet size area of machines in units. (Double crown = 1 unit, quad crown = 2 and eight crown = 4. Therefore quad demy, for example $= \frac{35 \times 45}{20 \times 30} = 2{\cdot}625$).

X_4 = number of operatives employed on the machines taken into account.

By inserting the values of X_1, X_2, X_3 and X_4 found in each firm studied it is now possible to construct an index of 'technical' efficiency as follows:

This index for sixteen firms is shown in Fig. II.3 below in order of ranking.

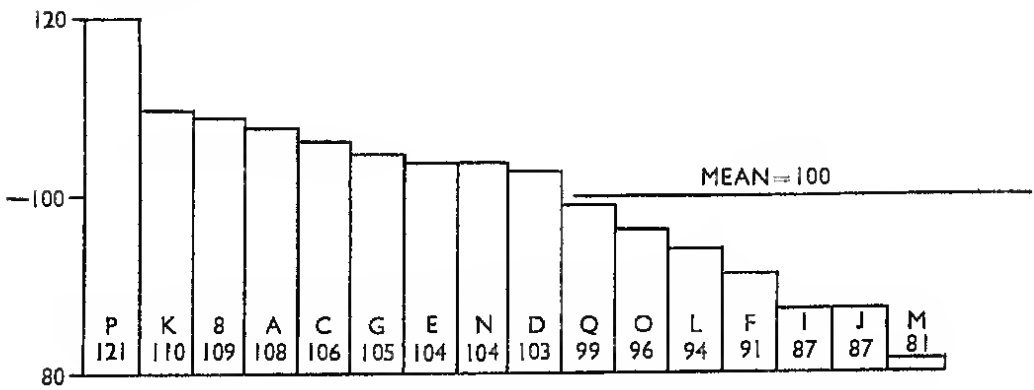

Fig. II.3. Index of technical efficiency

Two questions immediately arise in connection with this index:

(*a*) How reliable is the index? With two exceptions the order in which firms are placed by the index seems, from knowledge gained of these firms, to be satisfactory. There are other factors which may also be important, such as, the quality of work produced, the ability of the management, the condition of the machines, variation in type of work, and so on. These are factors which it was impracticable to measure objectively and so their effect cannot be calculated. This index indicates higher efficiency in those firms with an incentive bonus scheme. Of the first eight firms listed, according to the index, five have an incentive scheme in the machine room and a sixth has the scheme in other departments with a group bonus based on output in the machine room. The remaining two firms with an incentive scheme are ranked 10th and 14th.

(b) Can this index be applied to other firms? It is applicable to another firm subject to the following conditions:

(i) It must be similar in nature to the firms studied. (The index would not be expected to apply to a 100 per cent jobbing-work firm, and a high proportion of colour work appears to reduce the index slightly).

(ii) It should have between 10 and 40 machines of double-crown size and above, having an area (as calculated for this index) of between 25 and 110 units.

(iii) The period of records chosen should be about thirteen weeks.

3. EXAMINATION OF FACTORS RELATED TO MACHINE PRODUCTIVITY

MACHINE UTILIZATION

Summary

The actual running time of the machines studied is only about 40 per cent of the time they are manned. One way to increase production would be to increase the speed of machines above their present level of about 1000 impressions per hour. This is not always practicable due to technical limitations, and under present conditions, even if double speed was achieved production would only increase by a quarter. Greater scope for increased production lies in reducing the time the machines are not running, by using better methods and improving organization. More attention should also be paid to utilizing the size capacity of the machines by better planning.

Information relating to machine production was obtained from dockets kept by the machine minder. In all firms the three items on which reliance could be placed were the number of impressions produced, total hours worked, and number of jobs completed. When it was necessary to get a further breakdown of machine time, for example, to determine how long the machine was actually running, the errors involved could be quite large. In firms without an incentive bonus scheme the reason for this is that dockets are used for costing purposes, and since most of the time is chargeable at the same rate, there is no great need for accurate sub-division of this time. Furthermore the dockets are not filled in as soon as operations are completed, so accuracy is reduced by poor memory on the part of individuals. The firms with incentive schemes record operations on dockets in so-called 'standard minutes', and while accuracy is necessary in order to calculate bonus payments, some computation is required to convert standard minutes to actual time. The basis the investigators had for doing this was the machine minder's average bonus performance and some error was introduced by assuming that the rate of earning bonus was the same for both makeready and running.

In all firms there is a lack of definition as to which operations are included in makeready and which in running, and there are also large variations in the amount of detail (such as waiting times) recorded. Any comparison between firms based on such raw data therefore needs great care. Table II.1 shows the proportion of time various groups of machines spend on makeready, running on, and other time (oiling, washing-up and various delays).

It is certain that the figures for running on are too large because small stoppages, such as pile changes, are not recorded, and these may account for several per cent of machine time. The makeready percentage will also include unrecorded waiting times of small duration. These stoppages ought to be added to other time. During the investigation a complete breakdown of machine time into over fifty separate operations was carried out by direct observation in each firm. These results are given in detail in Part III. The technique used recorded what was happening during the particular studies and showed that the average running time for all machines of double-crown size and above was 38·6 per cent of machine time as compared with 45·7 per cent from production records.

Since machines are only running for about 40 per cent of the time,

Table II.1. Production of Machines

Type of machine	Percentage of machine time			Average length of run	Impressions per running hour (speed)	Impressions per total hours worked
	Makeready	Running on	Other time			
Eight Size Perfectors	39·6	48·9	11·5	20 300	968	475
Quad Size Perfectors	41·6	45·0	13·4	18 500	1035	465
Eight Size Auto-Fed Singles	46·1	41·2	12·7	10 250	990	408
Eight Size Hand-Fed Singles	54·7	31·9	13·4	4 000	856	273
Quad Size Auto-Fed Singles	38·8	50·2	11·0	8 000	1156	581
Quad Size Hand-Fed Singles	56·7	35·4	7·9	3 400	964	342
Double Size Auto-Fed Singles	30·4	53·7	15·9	8 000	1145	615
Double Size Hand-Fed Singles	40·8	41·5	17·7	2 300	1043	433
Quad Size Two-Colour	33·5	46·6	19·9	15 000	1255	585
All Machines Above	42·3	45·7	12·0	6 700	1066	487

one way to increase production is to reduce the remaining 60 per cent of the time the machine is manned. Two-thirds of the stopped time is accounted for by makeready, which is a necessary and chargeable operation in printing. Nevertheless, as some firms demonstrate, even this time can be substantially reduced by improvement in methods and organization. In general the firms with the higher 'Index of Efficiency' earlier described seem to have the better methods. Part III describes in detail the influence of methods and organization on the utilization of machine time.

Another approach to increasing production is to increase the running speed of machines. In nearly all firms the machines were

capable of running much faster than they actually did. There are however limitations imposed by materials, machines and men and these limitations become more apparent as speed is increased; too often the result is that valuable minutes saved by faster running are quickly lost in increased stoppages, or are paid for in reduced print quality. The problem then is to determine the most efficient speed on varying types of work of a short run nature. Usually, because quality is important, the safer course of low speed is chosen.

Figure II.4 shows the effect of speed on production, other factors remaining constant, when machines are normally running for various proportions of their manned time.

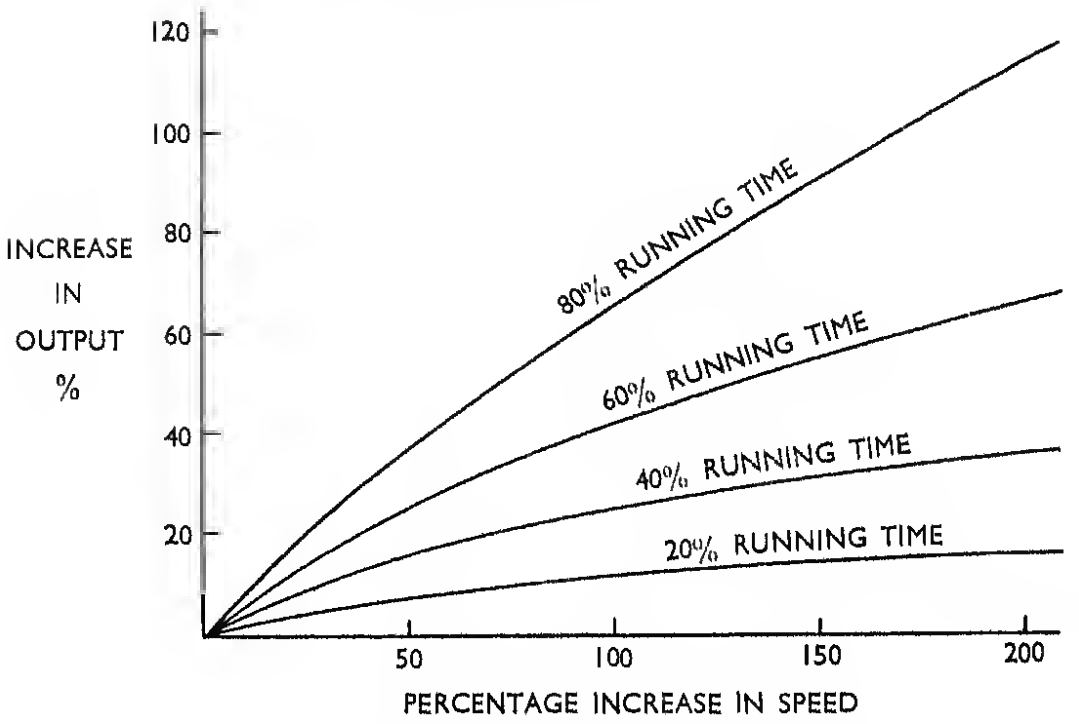

Fig. II.4. Effect of machine speed on output

For the average firm with 40 per cent running time it is seen that if running speed increased by one-half, the number of impressions produced per man hour will be increased by about 15 per cent; similarly, doubling running speed would increase output by 25 per cent. For the same firms a production increase of 15 per cent could also be obtained by reducing, or eliminating, other operations and delays which at present account for 13 per cent of machine time. This could be readily achieved in many firms.

The above diagram also indicates how speed becomes more important as the running percentage increases. Short run work, however, will always constitute the major part of flatbed letterpress printing; lower running time is a natural consequence of short runs and it therefore seems important that machinery manufacturers should concentrate more on devices which would facilitate the makeready of machines.

Finally the question arises as to how well firms utilize the size capacity of individual machines. This can be expressed as the ratio of the area of the average job to the maximum printing area of the machine. This machine capacity utilization in seventeen firms varied from 59 to 83·5 per cent with a mean value of 73·5 per cent; there is certainly room for improvement. A number of factors influence utilization: for example, some machines and some minders are more suitable for certain jobs than others; work is not standardized and in any event may have changed in character since the machines were purchased. Most important of all, however, is the lack of machine planning. Production planning is considered in detail in Part IV but at this stage it should be noted that some firms do plan their jobs well and achieve a high level of capacity utilization. The benefits of high utilization are obvious.

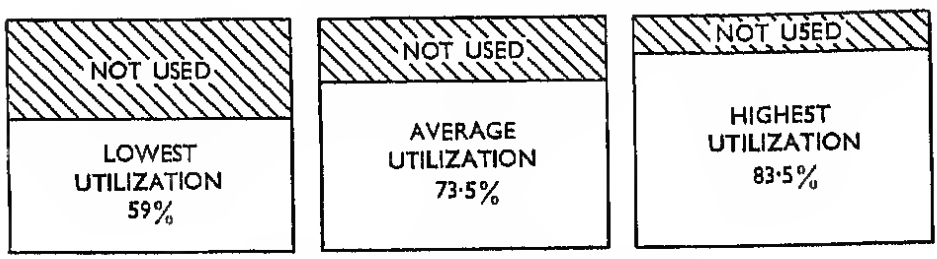

Fig. II.5. Machine capacity utilization

AGE OF MACHINES

Summary

The average age of all machines considered is 30 years (in 1958) and roughly the same average age was found in different machine groups and different firms. Age of machines in itself is therefore not of any consequence when considering the productivity of the firms studied. Comparison of auto-fed quad-size machines shows that post-war machines are on average running 12 per cent faster than pre-war machines. The variation is large, however, and some older machines are running faster than some newer ones. Age may affect the condition of machines and this could be an important factor in determining stopped time.

The 423 machines of double-crown size and above in the firms have an average age of 30 years (1958=0) and only eight per cent of them are post-war purchases. Most of the different types of machines have the same average age, the exceptions being eight-size singles (38 years) and two-colour machines (17 years). Half of the two-colour machines are post-war. The average age of machines in individual firms is again about the same. Because of this lack of variation there is insufficient evidence to determine the effect, if any, of age of machines on the productivity of any firm.

Comparing auto-fed quad-size machines pre- and post-war, the running speeds are 1226 impressions per hour (24 machines) and 1382 impressions per hour (15 machines) respectively. The post-war machines thus run 12 per cent faster and this difference is statistically significant (see Appendix B). A similar comparison for auto-fed quad two-colour machines gives the speed of pre-war machines as 1254 impressions per hour (12 machines) and post-war as 1366 impressions per hour (7 machines). The speed difference of 9 per cent in this case is not statistically significant due to the large variation in speeds prevailing. The effect of incentive schemes on these comparisons has been taken into account, although the effect of machine minders remains. Generally, firms put their best men on the new machines and this in itself might be responsible for the increased speeds.

Age therefore does not appear to be important as far as speed is concerned. What may be important is the effect of age on the condition of machines which in turn will affect the makeready time. In this respect a new machine has a greater chance of being in good condition than an older one, for the same degree of maintenance. However, it was not possible to measure the condition of machines, although some obvious defects were noted, during the investigation.

4. OTHER FACTORS INFLUENCING PRODUCTIVITY

PERSONNEL

Summary

Greater attention should be given to the study of personnel. In particular, the most economic and efficient balance between different grades of employees should be ascertained. Labour turnover of females is high in several firms and because of its effect on productivity it should be investigated in detail.

Table II.2 shows the total number of employees in the sample of firms and the proportions of males and females.

Table II.2. Personnel Employed

Firm	Total employees	Percentage		Firm	Total employees	Percentage	
		Male	Female			Male	Female
P	122	76·2	23·8	L	355	51·3	48·7
O	130	80·0	20·0	C	366	83·3	16·7
H	154	77·9	22·1	A	614	70·0	30·0
F	223	81·8	18·2	N	843	72·4	27·6
K	254	73·6	26·4	J	857	55·9	44·1
M	265	83·8	16·2	I	892	69·1	30·9
E	280	80·7	19·3	G	1068	(Not known)	
Q	293	68·9	31·1	B	1469	75·7	24·3
D	312	74·8	25·2				

The variation in ratio of males to females is due to the variation in the amount of warehousing or bindery work carried out in the firms; these operations normally employ a relatively high proportion of female workers.

A breakdown of all employees, other than bindery workers, into various grades is shown in Fig. II.6. These figures show the average values for all firms.

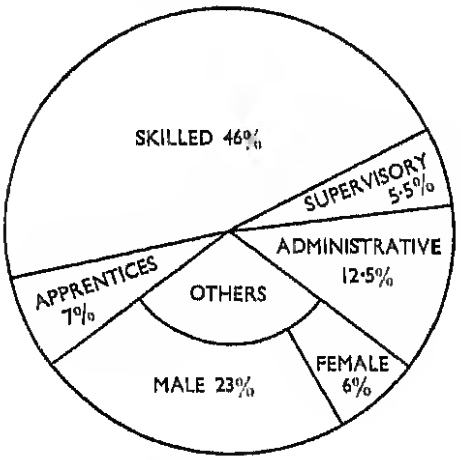

Fig. II.6. Composition of employees (excluding Bindery)

Administrative and supervisory staff together form what is officially known as 'Administrative, Technical and Clerical Workers', (Board of Trade definition). The proportion of these is increasing steadily in most industries, including printing, and examination of records shows this to be true of the firms studied. Where past production records are available it appears that the increase in such staff is not always compensated for by an equivalent increase in production.

Firms with an incentive scheme have on average four extra administrative staff per 100 employees as compared with those firms without such schemes. These extra staff are required for running the scheme and in utilizing the information that the scheme generates.

To illustrate how many firms lack a sound employment policy there is on the one hand the tendency already mentioned to employ persons without making correct or full use of them, and on the other hand the tendency to understaff the supervisory and the semi-skilled personnel. In this survey the firm with the lowest proportion of supervisory staff (3·6 per cent) had 16 per cent waiting time in the machine room. A further supervisor here could easily halve this waiting time and so increase production by the equivalent of an extra machine. This saving alone would more than pay the supervisor's salary and other expenses. The firm would not have allowed this state of affairs had it been aware of the production loss involved. This instance typifies lack of information that causes many of the organizational faults found at the firms visited. In investigating the distribution of different grades of employees in the various departments it was necessary in several firms to make a physical count and then to ask the supervisor for details of those who were absent.

As well as ensuring that there is a correct balance between supervisory and other employees, firms should also examine the ratio of skilled to semi-skilled personnel. In the printing trade the craftsman is the key factor in production and it is essential that his skill is used to the utmost. This can only be done by providing adequate assistance with non-craft operations.

Productivity is also affected by labour turnover but only two firms collected information on this with a view to subsequent analysis. Labour turnover can be expressed as a percentage and a commonly used formula is

$$\frac{\text{Number of leavers in a year}}{\text{Average number employed in the same year}} \times 100$$

For male employees the turnover is about seven per cent but for females it is 20 per cent, and in one firm as high as 38 per cent. The leaving rate for females is expected to be on the high side but these very high values would certainly warrant further investigation. It must affect the overall productivity of binderies since the operations the girls perform all require training, and it is probably a matter of several months before an operator becomes really proficient.

It is recommended that firms pay greater attention to personnel factors and develop a system of information that will show clearly the effect their employment policy is having on production.

WORK STUDY

Summary

The application of method study and work measurement to printing, with particular reference to the firms investigated, is briefly discussed. The main conclusion is that while work-measurement schemes are having a significant effect in increasing production there is a fundamental need for much more method study.

Work study may be divided into two main classes, work measurement and method study. Method study is the study of the procedure of carrying out operations so as to eliminate those that are unnecessary and to improve the remainder. Work measurement is the assessment of the work content of operations usually in order to introduce a payment scheme based on output.

In later parts of this report the need for improvements to methods, factory layout and so on is stressed; method study can play an important part in increasing the industry's productivity. Surprisingly little method study has been carried out especially where the results will affect skilled employees. One reason for this may be the attitude of some of the trade unions which until very recently did not allow the use of some measuring instruments, such as stop-watches, which are usually necessary for making quantitative comparisons of methods.

Greater strides have been made in work measurement as a basis for the introduction of bonus schemes for payment according to work content. One firm manufacturing business equipment introduced such a scheme in their printing department in the early '20s, and another firm was permitted by the trade unions in 1948 to introduce a bonus scheme as an experiment. It was not until 1949, however, when a new national wage agreement was signed, that the unions agreed to co-operate in the introduction of systems of payment by results. (It will be noted that this is about thirty years after they had been widely applied in other industries).

Since 1950 about ninety firms have put in such schemes, most of these using the same firm of consultants. It is not proposed to give details here how such schemes work, but those unfamiliar with them may care to consult two useful references specific to printing. ('A System of Payment by Results' by Brooke Crutchley, C.U.P. 1949, and 'Code of Guiding Principles Relating to Work Measurement Incentive Schemes', drawn up by The British Federation of Master Printers, the Newspaper Society, and the Typographical Association).

Nine of the firms visited have these incentive schemes in operation and on the basis of this sample the following observations are made:

(i) The employees are rarely adequately educated on how the schemes operate and this ignorance is the cause of some antagonism towards such schemes.

(ii) When these schemes are introduced virtually no method study is carried out beforehand. The main reason for this is that consultants are expensive and the employers want to see some return for their money as soon as possible. The employees are also in a hurry to achieve some financial gain especially when they see that some of their colleagues in other departments, which have already got the scheme operating, are getting an extra few pounds a week.

(iii) Because so little method study is applied it is possible for employees to earn bonus on inefficient and even unnecessary operations. The employees have then an incentive to improve methods themselves; if they do they can either achieve a very high bonus or alternatively earn a reasonable bonus with very little effort. Taking the basic rate as 100, bonuses as high as 240 have been attained by some workers in a few firms. Such high values imply that the times set for operations are too 'loose'. In general firms do little re-timing in order to correct these loose values because of the antagonism this causes with the employees. Most bonus schemes, however, set a top limit of 167 on bonus earnings mainly in order to safeguard quality.

(iv) Employees not only make improvements in methods but they also indirectly improve organization. For example,

waiting time is paid for at day rates, which lowers the employee's overall bonus, and so pressure is brought to bear on management to reduce delays.

(v) One of the potential benefits of work measurement schemes is the accurate recording of operations and output they require; this provides quantitative information which might not otherwise be available for management control. Further, since the work content of jobs is known it is possible to improve costing, estimating and production planning and control. The team were surprised to find some firms who were not using these benefits.

The points above are not intended as a general criticism of incentive schemes but rather to show that some improvements in the running of them are desirable.

Obviously the introduction of these schemes does increase production and in this respect the Index of Efficiency developed earlier in Section 2 demonstrates that the firms with incentive schemes are efficient producers; on the other hand the efficiency of methods and organization in these firms are about the same as in firms without incentive schemes. (This is demonstrated in Table III.1 in the next Part, from which it can be shown that the average waiting time of printing machines in firms with an incentive scheme is 10·7 per cent of machine time as compared with those without schemes which have 7·9 per cent waiting time). The need for method study is just as great in firms with incentive schemes as in the others and it is logical to make as many improvements as possible in methods and organization before work measurement is applied. In this way many of the shortcomings found would be eliminated.

5. OTHER MEASURES OF PRODUCTION

BOARD OF TRADE CENSUS OF PRODUCTION

Summary

Census of Production returns are a convenient form of financial information. Such information is however easily affected by the nature of the work carried out in a firm. The information also demonstrates a need for studying financial problems such as the amount of capital tied up in work in progress and in stocks.

All the firms visited make the Annual Census of Production Return to the Board of Trade. This is a convenient source of certain employment and financial data and figures were collected for the years 1954 to 1957 inclusive. The 1954 census was the last complete census available. Financial comparisons of the recorded information over a relatively small sample are not of great value owing to the variety of

work performed by the firms. Certain data are also subject in some instances to large errors, particularly such items as value of work in progress or material stocks.

Sixteen of the seventeen firms came under the classification of 'Printing and Publishing, Bookbinding, Engraving, etc. Industry'. Comparison of the sample of firms with the industry as a whole is given in Fig. II.7. This shows the mean percentage (and range of values given in brackets for the sample) of the items which comprise gross output. Gross output is defined as the total value of sales, adjusted for changes in value of stocks and work in progress, during a year.

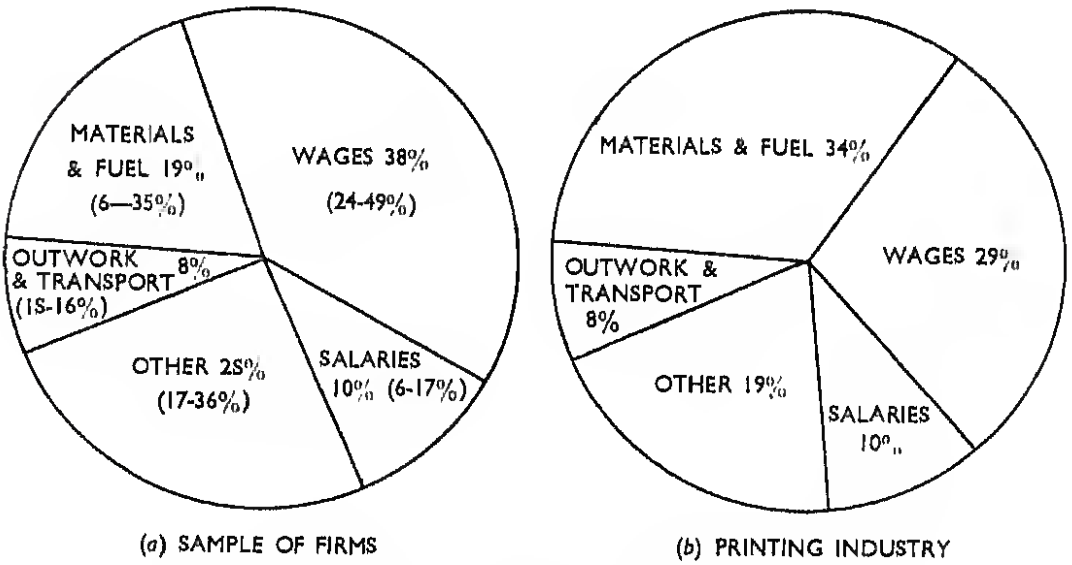

Fig. II.7. Composition of gross output

For the survey sample of firms it is seen that materials cost seems to be of secondary importance, but this is because in most of these firms the paper is bought by the publishers. However, from the printers' standpoint, the high labour content of work in these publishers' printers gives added weight to the need for studying methods, even though for the printing industry as a whole raw-materials cost is an important factor.

Gross output is unsatisfactory as a measure of efficiency. If, however, the costs of materials, fuel, outwork and services are deducted, another common measure known as 'net output' is obtained. Even in this, variation between firms is large, the highest net output per employee being double the lowest, owing to the different kind of work undertaken. A slightly better measure of efficiency is the proportion of net output taken by wages. This is normally unaffected by such changes as increased wage-rates since the increases are passed on to the price of the product. This particular ratio is in fact made the basis of a group incentive scheme known as the 'Rucker Plan', or

the 'Share of Production Plan', which has recently been introduced in several printing firms. If there is an increase in labour productivity the proportion of net output taken by wages decreases by virtue of increased output for the same labour cost. The percentage of net output taken by wages in the various firms is shown in Fig. II.8.

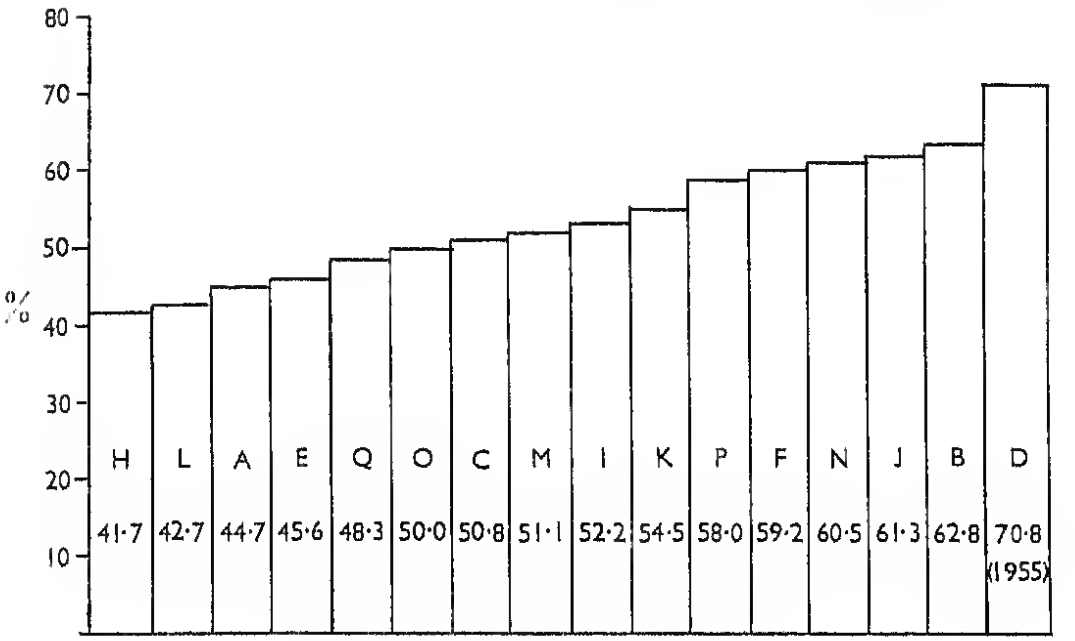

Fig. II.8. Percentage of net output taken by wages

Apart from the potential use of this ratio as a measure of productivity over a period of years it may also be of value in comparing firms provided that account is taken of the type of work they produce. A number of firms in the above diagram perform a good deal of hand work notably in the bindery, so it is unfair to compare these directly with firms who do no binding work at all.

Analysis of these records shows further that some firms have a high proportion of capital tied up in materials and in work in progress. For the latter the average value is 11 per cent of gross output but for three firms it exceeds 20 per cent. Such high values seem to be associated with the printing of technical books but nevertheless it seems desirable to examine these aspects more closely to see whether the capital employed can be used more efficiently.

MISCELLANEOUS

Summary

Other records available are briefly considered. These are quad sheets printed (from returns of book printers to B.F.M.P.) and paper usage.

Other records obtained where possible are detailed in Appendix A. Apart from attempting to measure productivity in all departments

some were also collected to find whether there was any more accessible record than dockets for measuring machine productivity. Two such records are available in many firms.

The quarterly return of book printers to the British Federation of Master Printers gives the number of sheets printed (in terms of quad sheets). It has been possible to check the accuracy of this record against data recorded on dockets and it is quite evident that some firms rely on inspired guesses. These unfortunately are of no use to this survey. The returns detail also the number of sections sewn and books bound. It is not always possible to check the accuracy of these figures owing to the lack of other records, but in view of the errors in the number of printed sheets, the value of the data is questionable.

Secondly, the amount of paper used in a given period can generally be deduced from stock records. More commonly the record is of the paper received, and the assumption is made that stocks remain reasonably constant. Fig. II.9 shows a plot of the number of impressions produced against the tonnage used by each firm in the same

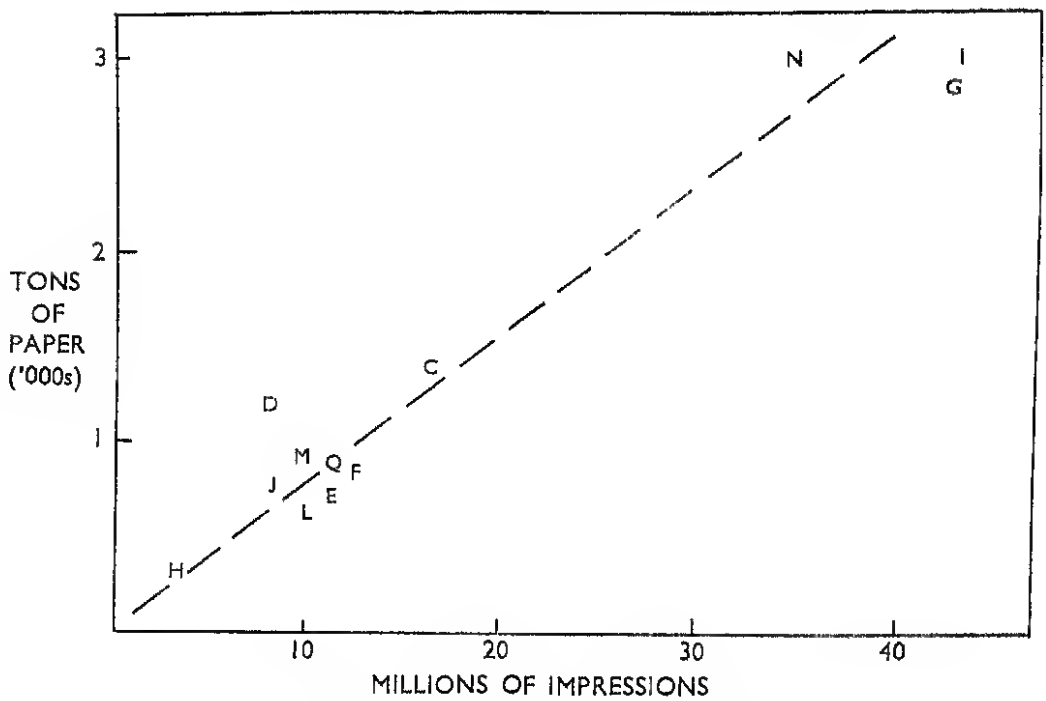

Fig. II.9. Paper used as a measure of output

period for which records were available. Without any further corrections, such as for size of machine, the data seem to fall on a straight line. Although the tonnage of paper may be suitable for an approximate measure of output, when a large number of firms are to be examined, it would not be of much value in a sensitive index of productivity such as the regression index developed in Section 2.

As regards other records, it has already been mentioned that they are available only from a few firms and even then are often in an unsuitable form for further analysis.

Part III. The Machine Room

1. INTRODUCTION

This Part is concerned with the methods and organization of the machine room. Many printers will be aware of the different methods in use in the industry but information on the efficiency of the various methods has hitherto been unobtainable. This investigation provides a means of comparing the efficiency of different methods in terms of the proportion of machine time spent on the different operations. It is not only the general method which is important but the detailed procedure of the method. This examination of detail needs meticulous care, as is provided by proper method study, and its importance cannot be too strongly stressed. It may seem trivial to record that a machine minder spent five minutes searching for a mechanical overlay but if five minutes per day can be saved by eliminating unnecessary operations production would be increased by about one per cent.

The first stage of the investigation was to obtain a detailed breakdown of machine time. No firms have such an analysis and this lack of quantitative information has several deleterious effects. In the first place the firm has no criteria to judge the effect of changing particular methods. For example, many firms feel that improvement in machine productivity will result simply from changing over from wood to metal for furniture and quoins. This involves heavy capital expenditure, and such a change has not in itself been shown to have any real effect. It would improve productivity, however, if accompanied by more fundamental changes in procedure such as the introduction of horizontal forme transport and storage. Another effect of lack of data is that problems quoted are not always the important ones. As an example of this, firms often quote the rising of spaces and furniture as a serious problem whereas in fact only 0·6 per cent of machine time is lost from this cause. In the same way these firms do not mention other problems such as waiting for position sheet (averaging 1·1 per cent of machine time) or even waiting time as a whole (averaging 9·2 per cent of machine time) simply because these matters have not attracted their attention.

To obtain quantitative information on machine utilization a technique known as 'Activity Sampling' was used.

Table III.1. *Summary of Activity Sampling Results*

Code No.	Operation	Firm A*	B†	C*	D	E	F	G*	H*	I*	J	K	L	M	N*	O	P*	Q*	Mean	Code No.
Running on													(Percentage of machine time)							
1	Running on	48·5	47·8	46·7	46·6	45·7	44·1	42·1	39·3	38·7	35·6	34·8	33·7	32·9	32·8	30·5	29·9	26·4	38·6	1
Makeready																				
2	Dressing cylinder	1·5	1·9	1·7	2·0	1·6	1·5	1·2	1·9	1·8	1·7	1·0	1·5	1·9	1·8	1·4	1·7	2·6	1·7	2
3	Put formes/plates on machine	2·6	1·4	1·9	2·0	3·2	2·6	2·6	4·6	3·6	1·3	2·4	2·9	2·6	4·7	8·9	2·6	3·5	3·1	3
4	Register formes	1·6	2·9	3·2	2·8	5·2	1·2	2·6	2·5	5·4	3·2	5·4	7·0	4·9	4·9	6·2	5·1	4·0	4·0	4
5	Register plates	0·6	0·7	2·2	—	0·8	1·6	0·5	—	0·3	4·1	—	0·7	4·9	2·5	2·0	3·1	4·5	1·7	5
6	Ruling-up sheet	1·2	0·1	0·6	0·1	0·3	—	—	—	—	—	—	—	—	—	2·0	1·7	3·0	0·5	6
7	Underlaying boards and blocks	—	0·2	0·2	0·3	0·2	0·1	0·9	—	0·9	0·2	—	0·1	0·3	—	—	—	—	0·2	7
8	Patching interlay	—	—	2·3	—	0·4	1·0	0·1	—	—	0·5	—	4·9	4·2	0·1	—	0·1	1·7	0·9	8
9	Interlaying plates	—	—	0·4	—	0·5	0·7	0·1	—	0·2	1·6	—	3·8	1·4	0·6	—	0·8	1·8	0·7	9
10	Patching overlay	5·0	12·3	11·0	5·0	5·5	4·7	6·1	1·1	7·6	4·4	2·2	10·3	4·2	8·8	6·1	4·9	7·1	6·3	10
11	Makeready on cylinder	7·7	6·0	5·7	5·2	4·8	8·4	5·9	3·3	9·0	7·4	7·4	2·7	10·2	5·3	5·0	10·7	3·4	6·4	11
12	Making mechanical overlay	—	—	—	0·2	0·2	—	—	—	1·0	0·6	0·8	—	—	—	1·4	—	—	0·3	12
13	Inspect sheet	4·1	4·0	4·4	2·3	3·1	4·2	2·6	2·5	7·0	5·9	3·0	4·2	2·9	5·1	2·7	3·8	4·5	3·9	13
14	Mark sheet	1·9	0·5	0·5	0·7	0·3	1·3	0·9	0·7	2·0	1·7	1·1	1·6	2·9	1·3	0·9	2·3	1·6	1·3	14
15	Set feeder and/or delivery	1·0	1·2	1·6	1·4	1·2	1·6	1·2	1·9	1·4	2·3	2·6	1·8	1·1	0·6	1·8	2·3	2·0	1·6	15
16	Set ink/rollers	1·6	1·4	1·4	2·9	1·1	2·2	1·2	2·2	2·5	3·6	5·1	3·7	2·2	1·5	2·0	3·2	2·5	2·4	16
17	Other mechanical adjustments	1·3	1·8	0·9	1·1	0·6	1·8	0·5	0·9	1·1	1·7	0·9	1·1	3·1	2·4	1·0	0·8	1·1	1·3	17
	Total 2–17	30·1	34·4	38·0	26·0	29·0	32·9	26·4	21·6	43·8	40·2	31·9	46·3	46·8	39·6	41·4	43·1	43·3	36·2	
Waiting and other delays																				
18	Waiting machine revise	0·5	0·5	0·4	0·5	1·6	0·3	0·3	7·2	0·3	0·4	0·2	0·1	—	5·4	0·2	1·2	0·6	1·2	18
19	Waiting position sheet	0·6	0·9	—	1·5	0·6	0·6	3·3	0·3	0·4	0·7	1·0	1·1	0·2	1·6	4·8	0·1	0·4	1·1	19
20	Waiting machine pass sheet	1·3	0·7	1·3	1·0	0·7	3·3	2·0	0·1	1·4	0·9	1·5	0·9	0·9	0·6	0·7	0·3	1·2	1·1	20
21	Waiting instructions and work	—	0·2	—	0·3	0·4	0·4	0·7	9·2	1·0	1·2	4·8	0·1	0·4	1·3	3·2	0·7	0·8	1·5	21
22	Waiting wet work	—	0·6	—	0·8	0·6	0·3	1·1	2·1	—	1·3	0·5	0·2	0·4	—	1·6	0·8	0·9	0·7	22
23	Waiting corrections to type	0·5	0·4	0·8	0·7	2·3	0·9	1·6	0·6	1·3	0·8	0·2	—	1·6	0·7	0·9	0·1	0·8	0·8	23

* These firms have an incentive bonus scheme in the machine room.

† This firm has a group output bonus scheme in the machine room (individual incentive bonus in other departments).

Table III. 1 (continued)

Code No.	Operation	Firm A*	B†	C*	D	E	F	G*	H*	I*	J	K	L	M	N*	O	P*	Q*	Mean	Code No.
		(Percentage of machine time)																		
24	Compositor on machine	0·5	0·1	0·3	1·2	1·4	1·1	2·8	4·6	0·2	0·4	1·4	0·2	—	0·5	2·3	1·1	1·5	1·2	24
25	Waiting corrections to plates	0·6	1·1	0·3	0·4	0·2	0·3	1·0	0·2	0·4	1·2	1·1	—	—	0·3	—	5·0	2·8	0·9	25
26	Other waiting (paper, ink, forme & assistant)	—	0·6	0·3	1·5	0·7	0·2	1·2	1·2	0·6	0·5	1·7	—	0·3	2·1	2·3	0·9	1·2	0·9	26
	Total 18–26	4·0	5·1	3·4	7·9	8·5	7·4	14·0	25·5	5·6	7·4	12·4	2·6	3·8	12·5	16·0	10·2	10·2	9·2	
Stoppages during run																				
27	Pile change (hand)	1·6	0·3	1·1	0·8	1·7	1·0	—	0·8	1·4	1·7	2·3	0·3	2·8	2·7	0·7	1·3	0·9	1·3	27
28	Pile change (auto)	1·3	0·9	0·5	1·2	1·8	0·9	0·4	0·7	0·4	1·0	0·5	0·8	0·4	0·2	0·4	0·6	0·8	0·8	28
29	Loading feeder	—	0·4	0·2	2·2	1·3	0·2	2·4	0·6	0·2	0·6	1·4	1·1	—	0·2	0·7	0·4	0·6	0·7	29
30	Bad paper feed	0·4	0·2	1·0	1·3	1·0	0·4	0·8	—	1·0	0·4	0·2	0·2	0·6	0·2	0·5	0·7	0·6	0·6	30
31	Rising spaces	0·8	0·4	0·9	1·0	0·4	0·6	0·9	0·5	0·5	0·3	0·1	—	1·0	1·2	0·4	0·3	0·6	0·6	31
32	Re-register	—	0·3	0·3	0·3	0·1	0·5	—	—	0·4	0·3	0·3	0·9	1·0	0·3	0·2	0·7	0·4	0·3	32
33	Touch up cylinder	0·4	0·3	0·5	1·0	0·6	0·6	0·4	—	0·3	0·4	0·9	0·2	—	0·3	0·2	1·1	0·2	0·4	33
34	Inspection sheet	—	0·1	0·6	0·5	0·7	0·3	—	0·1	0·5	0·3	1·1	0·1	0·7	0·1	0·2	1·0	0·8	0·4	34
35	Mechanical adjustment	1·5	0·9	0·9	1·3	1·6	2·1	1·0	0·6	1·0	0·3	2·0	0·7	—	0·5	2·1	1·7	2·1	1·2	35
36	Mechanical breakdown	0·7	0·7	0·3	0·9	0·2	0·3	0·5	0·2	0·5	1·2	0·9	0·2	0·1	0·4	—	1·0	2·5	0·6	36
	Total 27–36	6·7	4·5	6·3	10·5	9·4	6·9	6·4	3·5	6·2	6·5	9·7	4·5	6·6	6·1	5·4	8·8	9·5	6·9	
Other operations																				
37	Clean and oil machine	—	0·7	0·1	—	0·2	0·6	0·3	1·4	0·4	0·6	2·0	0·8	0·2	0·7	0·8	0·8	1·2	0·6	37
38	Wash-up	0·6	1·2	0·1	1·8	0·1	1·4	1·4	1·2	0·2	0·5	2·0	0·6	1·4	1·7	—	1·4	1·0	1·0	38
39	Cleaning out forme	1·7	0·9	0·6	1·0	0·8	1·6	1·2	0·9	0·9	1·8	1·1	0·8	1·6	1·4	0·4	0·8	1·0	1·1	39
40	Clear machine (end of run)	1·8	2·5	2·9	2·8	3·7	2·2	2·6	3·8	2·6	1·2	2·2	1·4	3·5	3·7	2·9	2·3	3·5	2·7	40
41	Miscellaneous	6·6	2·9	1·9	3·4	2·6	2·9	5·6	2·8	1·6	6·2	3·9	9·3	3·2	1·5	2·6	2·7	3·9	3·7	41
	Total 37–41	10·7	8·2	5·6	9·0	7·4	8·7	11·1	10·1	5·7	10·3	11·2	12·9	9·9	9·0	6·7	8·0	10·6	9·1	

* These firms have an incentive bonus scheme in the machine room.

† This firm has a group output bonus scheme in the machine room (individual incentive bonus in other departments).

2. ACTIVITY SAMPLING

Summary

This section describes briefly the technique used for determining the proportion of machine time spent on various operations. The accuracy of the technique is discussed and the individual results for the firms studied are tabulated.

This technique has several other names, is well documented (see Appendix B) and is widely used in many other industries. Briefly the technique used during the investigation was as follows. A list was made of all the clearly defined operations and causes of waiting and stoppages. Then at each firm the machines were visited in turn at random intervals and the particular operation being performed noted on each occasion. After about two weeks some 2000 observations had been recorded and from these were calculated the proportions of machine time spent in running and in stoppages for each of the various causes listed.

It was not always easy to determine what was happening at the machine purely by observation, and the machine minder was questioned when there was doubt. An example of the need for tactful questioning occurs when a machine minder is carrying out minor maintenance or alterations in order to occupy his time while delayed for some reason. Another difficulty arises when two operations occur simultaneously; for example, the machine minder may be patching an overlay whilst a compositor is carrying out corrections on machine. In such instances it is the primary operation, in this case that of patching overlay, which is recorded.

Table III.1 summarizes the activity sampling results for the seventeen firms studied in detail. Originally there were 58 operations listed and some grouping has been applied in the table. These results exclude machines smaller than double-crown size (although these were sampled in some firms when of interest) and also those machines manned by apprentices. Sampling was not normally carried out during the first and last half-hours of the day nor during recognized tea-breaks. This may result in a slightly high value for running and low values for the operations of washing-up, cleaning and oiling. The percentages for other operations will be negligibly affected.

The accuracy of the figures can be calculated statistically and for 2000 observations it can be assumed with reasonable confidence that an operation recorded as one per cent will lie within $1 \pm 0{\cdot}4$ per cent, for 10 per cent it will be $10 \pm 1{\cdot}4$ per cent, and for 50 per cent within $50 \pm 2{\cdot}2$ per cent.

Comparison of sampling figures with production records (i.e. dockets) is likely to be misleading for reasons previously noted in Part II. Generally, however, the agreement is fair and most discrepancies can be accounted for by differences in the definitions of running, makeready and so on. Comparisons can also be made with records kept by firms operating incentive bonus schemes. Over forty such comparisons were made and three-quarters of these give agreement within the limits of accuracy stated above. The remaining quarter are again largely accountable for by differences in definition and other circumstances. The general agreement adds confidence to the individual figures in Table III.1.

The various operations are discussed in detail in the following sections.

3. DRESSING CYLINDER

Summary

The operation of dressing cylinder accounts for an average of 1·7 per cent of machine time and there is little variation from firm to firm. The main variable in the operation is the supply of materials necessary for cylinder dressing. No quantitative evidence is available from the investigation on the effect on makeready time of different cylinder dressing materials.

The term 'dressing cylinder' covers the operation of stripping down the old packing, obtaining the new material, and placing this in position on the cylinder. The percentage times recorded for dressing cylinder are as follows:

Better than average		*Average*		*Worse than average*	
Firm	%	Firm	%	Firm	%
K	1·0	C	1·7	I	1·8
G	1·2	J	1·7	N	1·8
O	1·4	P	1·7	M	1·9
A	1·5			B	1·9
F	1·5			H	1·9
L	1·5			D	2·0
E	1·6			Q	2·6

There is not much variation between the firms for this operation. Firm Q is rather higher than the remainder because the 'permanent' packing on two machines was changed during the observations.

Materials used and procedure adopted are the same for most firms. There are a few firms, however, which do not supply cylinder dressing materials, except oiled manilla, and consequently the minder must be constantly looking for any spoilage sheets that may be of use for dressing. Some firms keep the materials in the machine room and the assistants collect it for the minder, in others it is kept in the paper store or warehouse and the minder may have to get it for himself. The time the minder takes to collect dressing materials may be small but firms which allow a minder to fetch these will generally allow him to perform similar unskilled tasks and so will not utilize his skill to the best possible advantage.

The materials and procedure used in dressing the cylinder may affect the time taken for subsequent makeready. There is in fact makeready of the printing surface and makeready of the machine. A number of firms are tackling the latter problem by placing a patched base sheet under the permanent packing to compensate for the inaccuracies of machine impression. To reduce the makeready of the printing surface on the other hand is a more difficult problem. Some firms are carrying out *ad hoc* experiments with resilient packings, such as rubber- or plastic-bonded calico sheeting, but on the whole the results so far are disappointing to them. The evidence is inconclusive as to whether it is the materials which are unsatisfactory or merely the way in which they are used.

4. POSITIONING AND REGISTRATION OF FORMES AND PLATES

Summary

The average proportion of machine time spent on the operations considered in this section is 9·4 per cent and varies from 4·9 to 19·1 per cent for individual firms. Although the time taken is affected by the type of work, the fact that some methods can reduce the time taken to virtually nothing shows that great savings of machine time can be made by examination and improvement of present methods.

This section covers four items.

(i) *Put formes/plates on machine.* This term applies to the operations of placing and positioning formes and plates on the machine. The operation of laying down of plates on the machine is carried out in several firms, and this is also included.

(ii) *Register formes.* A 'forme' is considered to be printing matter mounted in a chase with the pages separated by furniture and leads. The practice in four firms of mounting duplicate plates on individual mounts and imposing them in a chase is considered as registration of formes, since register is achieved by interposing leads and furniture.

(iii) *Register plates.* Here register is obtained by moving the plate on some mounting base. Under this heading colour blocks are also included when they are so mounted.

(iv) *Ruling-up sheet.* This refers to ruling up a position sheet when the operation is carried out by the machine minder. Eight firms allow this, but in all of these except the one firm in which the minder is responsible for position, there is also time spent in waiting for approval of the position sheet (see Section 10).

Figure III.1 shows the proportion of machine time spent on each of the operations considered in this section.

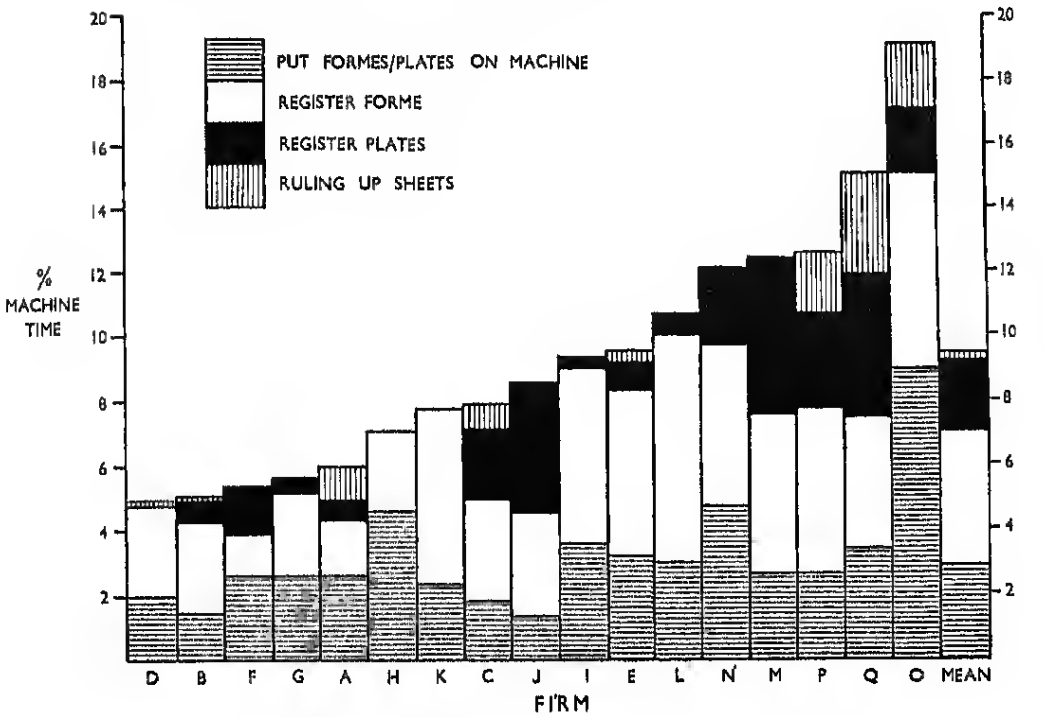

Fig. III.1. Position and register of formes and plates

It is seen that the per cent of machine time spent on positioning and registering varies from 4·9 to 19·1 per cent with a mean value of 9·4 per cent. Direct comparison of one firm with another may be misleading owing to variation in the type of work produced, but a number of broad conclusions can be drawn.

It is convenient to consider type and plates separately. In either case many improvements may involve capital expenditure, but an analysis by firms of their present procedure may well show that such expenditure would be fully justified. Some improvements can be made at a negligible cost.

TYPE FORMES

In the first place adequate planning of work and good inter-departmental communication would ensure that when two or four formes are to be printed together on the same press, the type is

imposed in chases of the same size. It frequently happens that this is not so and the time needed in positioning is therefore increased. Sometimes a chase has to be removed altogether and the pages re-imposed on the bed of the machine.

A good deal of time and effort is used by a compositor in imposing a forme accurately. The forme is then locked up sufficiently tightly to withstand the rough handling it gets before it reaches the machine. The force applied in locking up is often so great that the chase is distorted and the accuracy of lining up is lost; by the time the forme is on the machine, where the minder uses a relatively light lock-up, there is no indication of the care earlier applied. This means that the minder has to make good the deficiencies and in effect registering is done twice.

In three firms visited this difficulty has been overcome by transporting and storing the formes in a horizontal position so that only a light lock-up pressure is needed after imposing. Other firms have the necessary equipment for such accurate pre-register and horizontal transport but it is not being used to this end. The advantage of accurate pre-register maintained by sensible handling is shown by a typical case; out of two 32-page formes on an 8-size machine only one page had to be moved, and that by only one point! In fact, one of the firms with an incentive scheme that uses this technique does not allow any time at all to the minder for registration. (The reader may wonder why Fig. III.1 does not show three firms with virtually no registering time for type: this is because the procedure is not being used for all work in the firms concerned).

Apart from its use to preserve accurate registration the single-forme tilting-table transporter is also used as a means of transporting heavy quad formes. Most of the other trolleys (for transporting one to eight formes) are archaic and give rise to a great deal of damage to the chase as well as to its contents. Not surprisingly the battered type reaches quite serious proportions in some firms. It is not necessary that this should be so, for even the latter type of transporter can readily be designed to avoid forme batters, rough handling, and, incidentally, to reduce the fatigue of the user.

Firms having more than about thirty machines seem to find it advantageous to employ persons for the sole purpose of transporting formes to machines. In the other cases the transporting is usually carried out by the machine assistant. The formes for a machine may be situated in the machine room or left in the composing room but invariably in a rack, or racks, supposedly reserved for this purpose. Very often, however, these racks contain formes in all stages of working. Proper supervision, organization and clear identification of formes in the racks can again save time by reducing the search time for the appropriate forme.

As already mentioned, most firms spend a high proportion of machine time on registering formes. The procedure for registering is universal although it is a little more arduous when wooden quoins

are used. In this case when the forme is unlocked on machine the quoins originally used no longer fit and the minder has to sort through a box of quoins to find some that do. Ten firms use wooden quoins and furniture in the formes, while the other seven use, exclusively, metal furniture and mechanical quoins. The mean registering times for these two groups are respectively 4·5 and 4·0 per cent of machine time. Such a difference is not statistically significant (see Appendix B) and cannot be said to show any advantage for metal furniture and mechanical quoins as far as time taken is concerned. If, however, the latter are used in conjunction with the technique of locking up to machine pressure coupled with horizontal handling as earlier described, then registering time will be reduced to almost zero. Positioning and ruling-up time will also be reduced.

PLATES

Firms have good reasons for adopting their present plate-laying and registering procedures. Nevertheless if the aim is to increase machine utilization plates must be laid down and registered before they get to the machine. With the proper facilities the overall time and cost of the work will be reduced. Other changes, such as interlaying plates away from the machines, may also be necessary. This is the broad approach to the problem of plate registration which is considered in more detail below.

There are a variety of mounting bases and methods used for platework: plates may be waxed on to metal beds, pinned on wooden bases, or clipped on one of the number of proprietary metal bases which are available. All except waxed beds allow plates to be laid down at the machine, and half of the fourteen firms printing from plates do this to varying extents. The operation of laying down plates has been included in positioning, and for Firm L 80 per cent of the positioning time recorded is spent laying plates at the machine, and for Firms F and O the proportion is 30 per cent. In the case of Firm O the operation is laying colour blocks on to a dowelled base.

When plates are registered on the bases away from the machine, some device is available to assist the compositor; this may be a lining-up table, string frames, ruled sheet, or paper strips. When the machine minder has to lay down the plates at the machine, however, such means are not often available and he usually relies on a folding or flexible rule. If the plates are for a further working of the same job the minder can leave some of the clips or pins in the base after the earlier working and position the plates to these; this however is not usually of much help since plate edges are variable in location with respect to the printing area. There are many other factors to be considered when examining plate laying and registering procedures: plate laying away from the machine may necessitate having extra bases; the method used for registration in the plate-laying department must, in fact, be capable of the desired accuracy, and one must

consider whether the registration achieved will be partly destroyed when the plates are lifted at the machine to interlay them (see next section). In general, however, it seems that it is better (i.e. quicker for a given degree of accuracy) to lay plates away from the machine.

The use of any type of mounting base can result in the virtual elimination of registering time at the machine, provided that the bases are in reasonable condition and the necessary care is taken by the plate-layers. If, however, the method of laying down is such that the minder can move plates individually, then, it seems, he will move them. For example, when plates are waxed down on to bases the only way for the minder to achieve register is by moving the base as a whole. But if plates are pinned on to good wooden bases and pre-registered in the same way as wax beds, the minder achieves final register by tapping the plates with a hammer and drift in preference to moving the board. The accuracy of final register is the same for both wax and wood mounting.

Unless a few blocks have to be changed to print a different colour, colour blocks are not usually laid at the machine. Owing to the accuracy required, final register has at present to be achieved on the machine. The amount of registering time will depend as before on the method used for initial laying. The best way appears to be pre-registering the forme, in a pre-makeready department, on a machine of the same type as that to be used for final printing. Another good method is the use of optical registering devices; these however require great care by the operator to avoid errors of parallax. Several firms have these devices and no longer use them; other firms achieve very satisfactory results with the same equipment.

Finally, in considering the time spent in registration, the question of registering tolerance is important. The table below shows for two different firms the average number of moves that had to be made to plates, one firm working to a tolerance of one point, the other to a tolerance of three points. Both these firms produce similar types of work and in some cases produce work for the same publishers.

Table III. 2. *Movement of Pages in Formes*

Firm 1 Tolerance 1 point		Firm 2 Tolerance 3 points	
No. of pages	*Average moves*	*No. of pages*	*Average moves*
16	8		
32	39	16–128	1·2
64	87		
128	126		

Apart from the additional time required for the operation of registering, excessive attention to register may require the showing of further position sheets, so delaying the makeready and running of

the machine. Such insistence on position quality can hardly be reconciled with the tolerances at later stages in the production of books, particularly at the folding machine where tolerances of $\frac{1}{16}$ in. and more are acceptable. With the introduction of rotary letterpress machines and the use of flexible duplicate plates, the difficulty of moving plates after the forme is on the press leads to some relaxation of the tolerances allowed. Standards of one point on flatbed become three points or more on rotary and even where both processes are in operation side by side on similar or even the same work, the tolerance remains one point for the flatbed work.

5. UNDERLAY, INTERLAY AND OVERLAY

Summary

The average proportion of machine time taken by the operations of underlay, interlay and overlay is 14·4 per cent. These operations are performed to overcome deficiencies in machines, type, plates etc., so the first stage of increasing efficiency is to minimize such deficiencies as far as possible. Furthermore, some operations can be carried out with advantage away from the machine.

The three operations of underlay, interlay and overlay constitute the major part of making ready. Each operation can be considered separately although all three are inter-related. The work may be performed in several ways and the method used is to a large extent the personal choice of the machine minder concerned. This choice is not always an arbitrary one; much may depend upon the nature of the work, the materials to be used, the length of run, the quality of the work, and the skill of the machine minder. In firms operating a bonus incentive scheme, machine minders are given, or know, the standard time for each operation. This does fix to a certain extent the method of working, in that a minder would not normally do work for which he was earning no bonus.

The proportion of machine time taken in the various firms for the different operations is shown in Fig. III.2.

The value of 4·4 per cent for total time in Firm H is largely accounted for by the type of work, i.e. a high proportion of the work observed was of a short-run nature and part of this was regarded by the firm as of a lower standard than usual. The next lowest total of 9·6 per cent is for Firm K which produces a high proportion of colour work and the low figure appears to be due to the use of one of the newest types of mechanical overlay. Other relatively low values, for Firms D, E and O, are a reflection of type of work rather than method. The firms with high totals print a high proportion of work from plates.

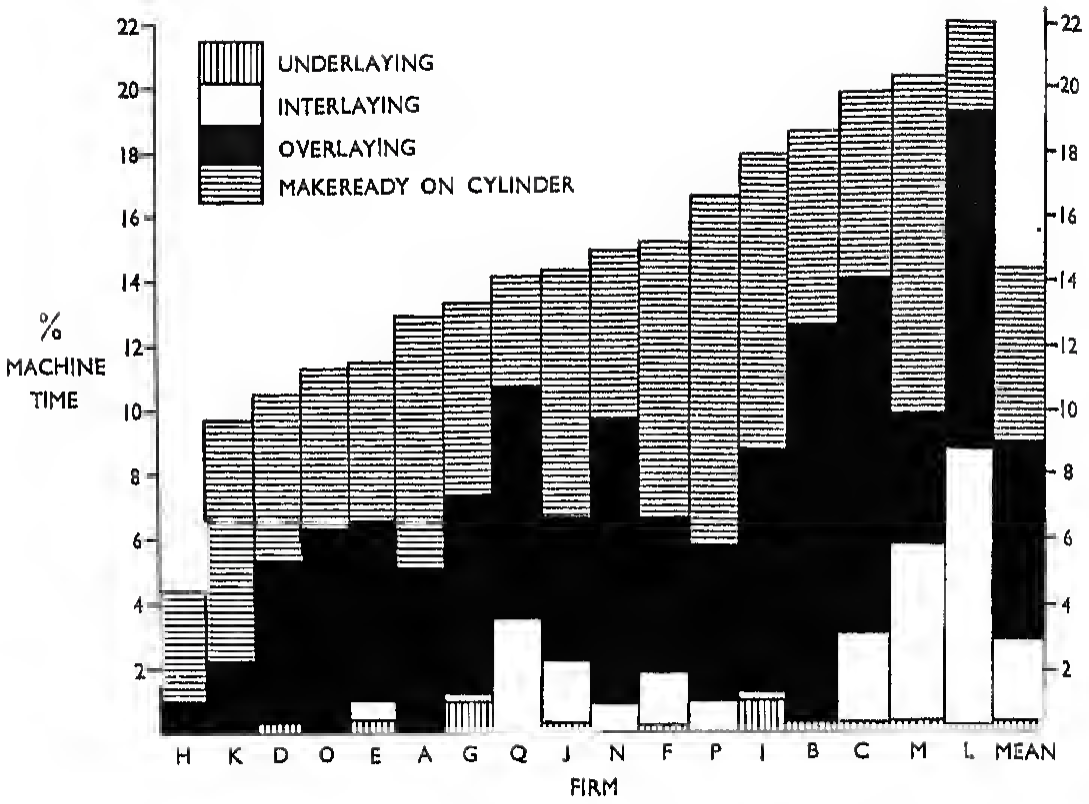

Fig. III.2. Underlaying, interlaying and overlaying

The prime object of using an underlay is to raise the printing surface to uniform height. This is to overcome the deficiencies in plates, in the bases on which plates are laid (this is the more usual reason), or deficiencies in the machine bed. Three firms check the height of beds of plates and supply the underlays to go with them to the machine; in other firms the minder has to determine and make the underlay. These are general underlays. In addition some firms use what may be termed a selective underlay, i.e. a piece of paper to compensate for a localized defect of the mounting base A third type is the patched underlay. This is made from an impression sheet since it is intended to compensate also for irregularities in the plates; how far this succeeds is a matter for conjecture. Patched underlays are used by firms mounting plates extensively on wooden bases but these firms still interlay the plates as well.

The interlay gives selective treatment to individual plates and blocks. In the latter case most firms use a mechanical interlay which is inserted when halftone blocks are remounted on metal. In only one firm, however, is any attempt made to interlay plates away from machine; this firm uses honeycomb base for mounting plates. A machine minder in the pre-makeready department proofs the plates, four up, on a piece of honeycomb base. He then patches an interlay, as would be done on the machine, and sticks this securely to the plate where it remains indefinitely; (keeping the interlay on the plate is practicable only when an accurate base is used and other firms have to interlay plates every time they are printed). To determine

whether plates could be interlayed away from the machine even when mounted on wooden bases the team carried out a test at one firm. Here 16 plates (mounted on a wooden base) were pulled up using a proofing press with flat packing. Comparison of the impression sheet with that obtained using the same base and plates on an 8-crown perfector (45 years old) showed that both had the same characteristics. The advantages of interlaying away from the machine are, firstly, increased utilization by removing this operation from the machine, and, secondly, it allows plates to be accurately registered away from the machine without fear of losing this registering accuracy when plates are lifted for interlaying. The latter operation, particularly with wooden bases where pins are used, takes a considerable time, and constant handling of plates leads to rapid deterioration in their quality.

Finally there is the overlay which is used to even the impression over the whole printing area. Mechanical overlays are discussed under Pre-makeready in Part IV. There are as many different procedures for patching an overlay as there are machine minders, and the equipment the firm provides for patching varies similarly. Again some minders prefer to do most of the overlaying by working at the patching table, while others do much overlaying by working at the cylinder. The variation is so great that from the present observations it is impossible to say whether the practice of one minder is better than that of another. This individuality can cause difficulties when minders are on shift work. If at shift changeover one minder has commenced patching, the next minder cannot always follow on and finds it easier to start again from the beginning. This has been noted at several firms. There are criticisms of individual firms that can be made as regards overlaying, in particular, failure to provide patching tables with suitable lighting. The time required for overlaying specific jobs depends mainly on the quality of the printing face, the quality of the work to be produced, and length of run. Of these, the first is the most important, and is the one the printer can control by ensuring good quality type and plates, and maintaining this quality throughout the operations carried out before printing.

6. MARKING AND INSPECTION

Summary

Marking and inspection during makeready account for an average of 5·2 per cent of machine time. This surprisingly high value is discussed.

The activity sampling totals for inspecting and marking sheets during makeready are:

Better than average		*Average*	*Worse than average*	
Firm	%	%	Firm	%
D	3·0	5·2	F	5·5
H	3·2		L	5·8
E	3·4		M	5·8
G	3·5		A	6·0
O	3·6		P	6·1
K	4·1		Q	6·1
B	4·5		N	6·4
C	4·9		J	7·6
			I	9·0

Additionally, inspection of the sheet while nominally 'on the run', but actually with the machine stopped, accounts for up to 1·1 per cent of machine time. Furthermore, the time required for passing sheets for position and quality (average 2·2 per cent), discussed in Sections 10 and 11, is mostly taken up by inspection.

Individuals vary in the amount of marking carried out. Some minders almost never use a pencil at all, while others mark everything on the sheet before doing their patching. Some firms discourage pencil marking before patching, but no clear distinction can be made between firms who mark the sheet and those who do not. It might be thought that the marking and inspection time in those firms operating bonus incentive schemes might be reduced in comparison with other firms. The mean times with and without incentive schemes are 5·7 and 4·8 per cent respectively, and while these are not significantly different in the sample available, it is true to say that the times in incentive houses tend in point of fact to be longer than those in non-incentive houses. One explanation of this – for which we have no figures in support – is that where an incentive exists there is a tendency for a minder to show a pass sheet as early as possible in an effort to get running as quickly as possible. This could lead to repetition in making good unsatisfactory work, and hence a longer time in marking and inspection.

Since, generally, plate work requires more makeready than type work it is interesting to note that those firms doing virtually no plate work (D, H, K and O) also spend comparatively little time on marking and inspection.

A small part of the total marking and inspection time is concerned with positioning and registering the forme.

7. MACHINE SETTING

Summary

Machine setting accounts for an average of 4·1 per cent of machine time. One item which would assist the reduction of this time is machine planning to avoid frequent changes in sheet size.

The following activity sampling items are totalled to give a measure of machine-setting time.

Item No.	Operation
15	Set feeder and/or delivery
17	Mechanical adjustments (during makeready)
35	Mechanical adjustments (during running)

The following are the machine setting percentages:

Better than average		Average	Worse than average	
Firm	%	%	Firm	%
G	2·7	4·1	M	4·2
C, E, H	3·4		J	4·3
I, N	3·5		P	4·8
L	3·6		O	4·9
A, D	3·8		Q	5·2
B	3·9		K, F	5·5

Although it might be anticipated that frequent forme changing would cause increased machine-setting time the records of forme changes do not indicate this. Firms K, F, Q have less than two forme changes per week per machine – the lowest figure recorded – yet these firms have the highest level of setting time. The time for setting does appear to increase with the proportion of automatic feeders and deliveries but there are notable exceptions.

Probably the greatest single factor affecting machine setting is the frequent change of sheet size from job to job, involving resetting of all the devices concerned with feeding the sheet through the machine and delivering it on the pile. This can be limited to a large extent by machine planning.

8. PILE CHANGING

Summary

Some 2·0 per cent of machine time is taken up in pile changing.

There is little general comment to be made about pile changing although there are a great many points specific to individual firms. As expected, there is a definite tendency for pile changing time to be lowest in those firms with a high proportion of pile deliveries. The following table shows the sampling percentages for pile changing

(both hand and automatic) together with the percentage of machines fitted with pile deliveries in each firm.

Firm	%	% pile deliveries	Firm	%	% pile deliveries	Firm	%	% pile deliveries
G	0·4	63	Q	1·7	92	K	2·8	77
O	1·1	67	I	1·8	63	A	2·9	74
L	1·1	56	F	1·9	62	N	2·9	12
B	1·2	91	P	1·9	63	M	3·2	36
H	1·5	43	D	2·0	43	E	3·5	18
C	1·6	43	J	2·7	57	Mean	2·0	

One firm places a pallet on the pile delivery stillage and facilitates unloading by using a fork-lift truck.

9. MACHINE REVISE

Summary

The various woys in which machine revise procedure is organized and the consequences are discussed.

The percentage machine time spent waiting for readers is as follows:

Better than average		*Averoge*		*Worse than average*	
Firm	%	Firm	%	Firm	%
M	0·0	P	1·2	E	1·6
L	0·1			N	5·4
K, O	0·2			H	7·2
F, G, I	0·3				
C, J	0·4				
A, B, D	0·5				
Q	0·6				

Ten of the firms employ only one machine room reader for from 13 to 30 machines. Four firms do not have a specialized machine reader at all, the revises being carried out by the composing room readers, while in four other firms the machine room readers also rule up and mark the position sheets. The high figure of 7·2 per cent for Firm H is due to unevenness in the flow of work. For long periods there is no revising to be done, and the reader's time is otherwise occupied. Then a number of revise sheets come at once, and there is this delay at the machines. The high figure of 5·4 per cent for Firm N is due partly to the high proportion of short-run work of a complicated nature (the firm was aware of the overload of work on the readers but had difficulty in getting suitable men) and partly to the organization of the correcting at the machine in accordance with the

marks made by the readers. In this particular firm the sheet passes from the machine reader to a box at the overseer's office and remains there until the compositor who does corrections is free to do that particular job. The more general procedure is for the reader to pass the sheet back to the machine, or back into the composing room, whence it finds its way to the compositor who has been concerned with the preparation of the forme, who then carries out the required corrections.

The difficulty with the 'box' procedure is that machines needing little or no correction are held up in the queue while the compositor is working on heavy corrections on another machine. This example of 'machine interference' would bear further investigation. The more usual procedure is for the minder to pull two sheets, one for position and one for reading, so that the position sheet can be returned quickly. A machine revise reader's job is essentially to check that proof reader corrections have been carried out, to see that the forme has not suffered damage ('batters') in its journey to the machine bed, and to check the positions of titles and similar matter having no definite fore-edge or head. Most machine revisers, it appears, are rather too conscientious and actually read all the copy as a final check on their reading room colleagues' work, feeling justified when they do find errors that have eluded all the previous readings. Several variations on the normal procedure are worked. In one firm, although the ruling-up is not carried out by the reader, it is the ruled sheet which is passed to the reader for revise, and again delay at the machine is caused since the minder cannot carry on with the work of registering the forme until the revise has been completed.

10. POSITION SHEET

Summary

The average proportion of machine time used in ruling-up and waiting for position sheet is 1·6 per cent. In three firms it is over twice this figure and the reasons are given. Certain points of ruling-up technique are discussed.

The accuracy of register of the pages of a forme on the bed of the machine is determined by ruling up a printed sheet on a special table provided with sliding straight edges set parallel to the edges of the table, and with means for fixing the sheet with the grip edge parallel to the long edge of the table. In eight firms minders rule the sheet themselves, determine the movement of pages necessary, and submit a final sheet for passing. In the remaining firms the ruling-up is carried out by a specialized operator who (except two firms) marks the changes required. Some firms combine this task with the duties of the deputy overseer. The percentage-machine times taken,

covering both ruling the sheet and waiting for the sheet to be ruled are as follows:

Better than average		*Average*		*Worse than average*	
Firm	%	Firm	%	Firm	%
M	0·2	D, N	1·6	A, P	1·8
H	0·3			G	3·3
I	0·4			Q	3·4
C, F	0·6			O	6·8
J	0·7				
E	0·9				
B, K	1·0				
L	1·1				

At Firm O the overseer rules the sheets; sheets are left at the table by the minders and when a small pile has accumulated the overseer rules them all at once. The overseer has no assistants and the high time value of 6·8 per cent is a direct consequence of this. The high figure for Q results from minders ruling two or three sheets before being satisfied. At Firm G the ruling is carried out by the machine room reader who subsequently carries out the machine revise on the same sheet. At Firm N, although there is a specialized ruler, the ruled sheet passes on to the machine readers. More generally two sheets are pulled, one for position and the other for revise; this procedure allows the minder to carry on with register work and other makeready while the revise is being read. At one firm the minder himself is responsible for position; he is not required to show a position sheet, but in case of subsequent trouble with the binders the minder is held responsible and liable to lose his bonus.

Two forms of ruling table are used. The simple kind carries plain steel rules, and the operator uses a pencil, a ball pen, or a piece of lead to rule the lines. There is a tendency to swing the hand when ruling so that a truly straight line is not drawn as often as might be thought. This is particularly so with a pencil, but even with a flat piece of lead errors can arise if this is not held at a constant angle to the ruling edge. This difficulty is avoided in the second kind of table which, in addition to the straight edges, is provided with a ruling wheel, inked by a small pad. This wheel cannot deviate from the straight line. Ruling-up tables are provided with plate-glass tops and internal lights. By using these the operator can check whether the second forme is backed up correctly on the first, or by superimposing two sheets, whether the required page movements have been carried out. In at least five firms the ruling-up table is positioned in the brightest part of the room, and so the effectiveness of the underneath lighting is greatly reduced; the operator has to use his hands to shade the sheet in order to see the reverse side. In two firms the table is set against a wall so that it is possible to work from one side only. However, in the other firms, where the operator would have worked from both sides of the table, he did in fact do so in

only one case; the other operators suffered the stretching and discomfort involved in leaning across to rule the far edge of a 40-in. sheet. To avoid this difficulty one firm uses a sloping table.

11. MACHINE PASS SHEET

Summary

The average time taken to pass a sheet at each firm has been calculated and varies from half a minute to thirty-eight minutes. Many firms attempt to justify this variation as reflecting the different levels of quality aimed at. Effects of organization are also discussed.

'Waiting machine pass sheet' as recorded by activity sampling refers to the period when the minder has finished the makeready and has submitted a sheet to be passed. The sheet is passed either by the machine room overseer or by one of his deputies. The examination is primarily for printing quality although position and register may also be considered. In a number of firms daily meetings of managers and overseers result in excessive waiting time, although a minder may then attend to other duties on or away from his machine. Managements are aware of this shortcoming in organization but consider the loss in productive time too small to warrant a change. The following table lists the percentage of machine time occupied in waiting for pass sheet. The second figure shows the average time taken, in minutes, for each machine working to be passed for running-on (as calculated from the activity sampling percentage and the number of workings done).

Firm	%	Time (min)	Firm	%	Time (min)	Firm	%	Time (min)
A	1·3	9·6	G	2·0	20·8	M	0·9	10·0
B	0·7	2·6	H	0·1	0·5	N	0·6	5·9
C	1·3	16·4	I	1·4	15·8	O	0·7	6·7
D	1·0	6·4	J	0·9	10·2	P	0·3	1·8
E	0·7	5·3	K	1·5	20·6	Q	1·2	9·2
F	3·3	38·0	L	0·9	10·0	Mean	1·1	11·1

There is little variation in the percentage figures, the only two outstanding firms being F and G. On the other hand the time taken in passing sheets ranges from half a minute to thirty-eight minutes. In Firm F this high percentage is attributed to the extreme care taken to maintain a high general standard of work. Impression is checked under an oblique light before the face of the sheet is examined for quality. A minder may have to submit three or four sheets before attaining the desired standard and being allowed to run on. All types of work in this firm receive the same meticulous attention. Firm G on the other hand, although recording 2·0 per cent of machine time

waiting pass sheet, is representative of a number of firms with the same departmental organization. The department is spread over a large area and may consist of a number of separate rooms or bays. The department overseer has an office in one room and delegates the day-to-day running of the machines to room or section deputies. Often the division of the department into rooms or sections for control by a deputy is not proportional to the amount of work involved. The work of a deputy in charge of a group of perfectors printing long-run bookwork may not be comparable with that of a deputy in charge of a group of mixed machines printing short-run jobbing or colour work. Extra work is involved in the latter case, and delays recorded as 'waiting machine pass sheet' are more likely.

In at least four of the firms visited the department overseer insists on passing the first working of any one job. Deputies may then pass subsequent sheets using the first sheet as a guide to colour and quality. In other firms all colour work must be passed by the overseer. Only in one firm do the machine minders submit sheets for examination during the run, and here it is a house rule to do so. Many firms, usually incentive houses, grade duplicate plates and other materials and allow the machine minders extra time for makeready with the lower grades. Only one firm (H) grades the work with regard to the finished quality required. Here there are three categories, and each job is assessed before the work enters the factory. Each job is then treated on its merits, the pass standard of quality being determined by the grading the job has been given. Some indication of the potential value of such a procedure is reflected in the very low time recorded for 'waiting machine pass sheet' at this firm.

12. CORRECTIONS

Summary

An average of about one hour per week per machine is lost due to corrections. The need for improvement in the procedure adopted by some firms is stressed.

The usual procedure for checking that the forme is satisfactory to print is to pull a sheet as soon as the forme is on the printing machine and send this sheet in to the machine reader. Any corrections necessary, due to previous corrections being missed, to type being damaged in transferring the forme to the machine, or to errors being noted for the first time, are marked on the sheet. A compositor then carries out the corrections, unless they are minor ones when, in some firms, the minder himself obtains the required type from the composing room and performs the corrections. Correction to plates generally involves lifting them and returning them to the foundry. Slight batters can be corrected without lifting the plate, and at one firm it is sometimes preferred to carry out corrections by soldering in new type at the machine rather than to lift a waxed-down plate and

so lose register. The percentage machine time taken up by corrections to type (including waiting) is as follows:

Better than average		*Average*		*Worse than average*	
Firm	%	Firm	%	Firm	%
L	0·2	F	2·0	Q	2·3
B	0·5			O	3·2
A	1·0			E	3·7
C	1·1			G	4·4
J, N, P	1·2			H	5·2
I	1·5				
K, M	1·6				

Two firms employ a compositor in the machine room for carrying out corrections (in one case the work being combined with the duties of machine room reader). Three firms employ compositors specially for machine corrections. At the other firms the machine revise is returned to the composing room, and usually the compositor who has been concerned with the job carries out corrections.

The high figures for Firms G and H are partly due to the practice of making 'alterations' at the machine. In one case pages are removed on the machine for the purpose of running off authors' reprints. In the other case small changes in the forme such as titles, or addresses, are made at the machine to avoid making up a new forme. In both these firms registering of the forme at the machine is the responsibility of the compositor rather than the minder, though the minder registers the forme if there is little or no correction to be done. The particularly low figures for Firms B and L arise because of the high proportion of plate work carried out at these firms; Firms A, C, N and P are low for the same reason. At Firm A the longer-run bookwork (from type) passes through a pre-press section where, in addition to other activities, a final pull of the forme is made on a quad machine and the 'machine revise' carried out before the forme goes to machine. Horizontal storage and transport ensure subsequent freedom from batters.

The mean value of 2 per cent of machine time for type corrections represents about one hour per week per machine. The greater part of this time is spent waiting. The compositor cannot down tools immediately and rush to the machine; somebody must take the revise to him, and he needs time to collect the type necessary for the corrections. In at least one incentive house it is accepted that half an hour elapses between the completion of the revise and the commencement of the corrections by the compositor. 'Walking time' is allowed at another firm as an item on which the compositor can earn bonus. Most of the waiting time and the correction time are concurrent with the overlay patching time and they are thus not recorded by activity sampling. The minder is not in fact held up with no work to do. This is the ideal to be aimed at, and is encouraged in one incentive house by allowing the minder to record correction

time on the machine even though he is fully occupied with patching, so that he earns extra bonus on the latter operation.

13. LAYOUT OF MACHINE ROOM

Summary

The chaotic conditions, as regards layout, in most machine rooms provide the major retarding influence on the adoption of improvements or mechanical handling methods.

As pointed out elsewhere, a printing firm grows slowly and as new machines are bought they are fitted in where there happens to be space. Printing machines last a very long time; some over 70 years old are still in regular use and are in reasonable condition. Both these influences lead to a generally congested machine room, with just sufficient space to load and unload paper and formes. Conditions are further worsened in those firms which use the machine room as an additional store for printed paper. The consequences of the congestion are numerous. Space does not permit the improvement of older machines by addition of automatic feeders and pile deliveries where these would be desirable. The proximity of machines to a wall or to other machines prevents the use of a tilting-table forme transporter and so accurate pre-registration is not practicable because the register would be lost in the transfer of the forme to the machine. Similarly, space does not allow the use of mechanical aids, such as fork-lift trucks, in servicing machines.

To clear such congestion a firm must either build a new machine room (or expand the present one) or, alternatively, get rid of some of the oldest machines. The latter is a more tempting proposition for, if machine utilization is increased, as discussed earlier, a reduced number would provide the same volume of work more efficiently. There is no fear of redundancy of men; in many firms there were idle machines for which no minders were available. The possibility of partial or complete shift working can also be considered. Finally, a redundant machine could be put to very good use in assisting pre-makeready, so further increasing the utilization of the remaining productive machines.

Part IV. Other Departments

1. INTRODUCTION

In Part III the machine room has been considered in detail, with particular attention to the effect of methods on machine utilization. Where appropriate the effect of other departments on the machine room are also mentioned. It is clear that it is not possible to look solely at a single department because of the close inter-relationships that exist between the departments comprising the firm. Because departments are so dependent on one another, 'bottlenecks' can easily occur; a very efficient organization to co-ordinate and control the flow of work is therefore required. Deficiencies in organization are considered in this Part and are dealt with under various departments. These deficiencies may not always occur in all the firms studied, but they are sufficiently widespread to be worthy of mention. Some other general factors with an adverse effect on productivity are also discussed.

2. ADMINISTRATION

Summary

Two important problems are outlined under this heading. The first is the need for an overhaul of organization generally, so as to establish a satisfactory chain of command and communication. Everybody in the chain, at all levels, should have specific duties and responsibilities. The organization should further provide channels for formal communication between departments. Secondly, there is the need for an integrated work planning system based on reality rather than hope.

GENERAL ORGANIZATION

The growth of a printing firm takes place slowly; new machines are bought, more people employed, and so on. In this way the firm develops rather haphazardly and this results in congested layout and other troubles. The organization also develops more by accident than by design. This is evidenced by the difficulty that directors experienced when asked by the team to draw up organization charts of their firms. Not only is there a lack of official organization in the

vertical direction but in the majority of firms the horizontal organization is purely informal. The latter depends largely on personal contact between overseers so that if there is conflict between them co-ordination must suffer.

Two main forms of organization may be distinguished. In those firms directly controlled by a works director responsibility is given to as few overseers as possible. Perhaps because the works director cannot devote all his time to purely works problems he prefers to have as few people directly responsible to him as possible. The second form of organization is that controlled by a works manager. In this case he finds the works easier to control in small units so as to give him more direct contact with individual sections; at the same time the authority and responsibility of any single overseer is reduced. Many shortcomings have been noted in each type but common to both is the failure to delegate responsibility or, more particularly, to instruct overseers and others as to the limits of their responsibilities and duties. Such failures become immediately apparent when senior men are absent for any reason.

Whatever system of organization is used it is necessary to design it so as to allow the necessary flow of instructions and information. It is equally important that the system is adhered to. In one firm, for example, each director deals personally with a number of customers and naturally enough each director tries to push his orders through the firm. This may be done without informing the necessary people, such as the works manager, and so causing serious delays to production schedules. A further weakness in many firms visited is the autocratic ruling of the senior director; often even trivial decisions, particularly when they involve money, cannot be taken without his consent. Any reform of organization needs to start at the most senior level and then work downwards.

PRODUCTION PLANNING

In printing, production planning is mainly concerned with the work load of the printing machines. In a few cases it is extended to other departments and in particular to Monotype keyboards; on the other hand, in some firms there is no production planning at all.

The machine room manager is usually responsible for machine loading except in those firms which have a planning office. In these latter cases the machine room manager is consulted about the most suitable machine for a particular job, as regards both machine and minder quality. Planning is not, however, entirely within the control of the firm and machines cannot often be loaded to advantage unless there are large numbers of formes awaiting printing or unless the jobs reach the machine room in accordance with some advance schedule. For this to happen, an overall planning scheme for the firm is necessary. One item that cannot be controlled by the printer

is the date on which proofs are returned, particularly in technical work. Few firms make any provision in the planning scheme for these delays or for other contingencies. Difficulties are accentuated in smaller firms which generally have less work in progress in the composing room; in some of these firms it is not known what job will be on machine tomorrow until today's post is opened. Other difficulties are the direct result of an inadequate system of planning; for example, a firm may plan the production of its machine room without informing its other departments of the dates to which the machine room is trying to work.

There are two main methods of planning. In the first of these the overseer makes out a rough programme as a guide, keeps a check on the progress of each job through the department and makes certain, whenever possible, that the job planned to be next will in fact be ready in time. This type of system is very flexible but too often it is only possible to plan a day or so ahead; with frequent changes to programme its results are generally not much better than in those firms which do not profess to have a planning system at all. The second method relies on a planning office working in conjunction with the overseer, with the planner doing the necessary chasing. In this case there is always the tendency to date the greater part of the work and to make no allowance for accidents and delays.

A high proportion of firms use visual aids, such as proprietary wall charts, for machine loading. These are of value for a system which is functioning correctly and permit rapid assessment of current progress. Such aids do not actually assist planning and are quite useless if the planning system does not work in practice. For example, in more than one firm these boards are filled up for months ahead but in fact the next job for machine is frequently not known until the previous job is completed.

The general conclusion is that work planning of all kinds is grossly inadequate; this subject should amply repay further investigation (see also Part V). A good planning system maximizes resources and is of great value in keeping the customer satisfied by adhering to the dates promised.

Summary

Steps required to remove odverse influences on productivity ond costs ore considered. They include reducing both outhors' corrections ond house corrections to type; ensuring good quolity type ond mointoining this quality throughout subsequent processes; providing good lioison between keyboords ond costers; orgonizing an orderly flow of work through the composing room so os to reduce non-productive time and duplicotion of materiols; providing the mochine with o forme thot is os perfect os possible — subject to cost considerotions; moximizing the life of duplicote plotes; ond standordizing procedures in certoin foundry operotions. Finolly storoge and hondling of poper requires detoiled investigotion, os does the locotion and control of bindery mochinery.

COPY PREPARATION AND MONOTYPE KEYBOARDS

Where information is available it appears that one-fifth of all compositors' time is spent in making authors' corrections and a further fifth in making house corrections. The object of copy preparation is firstly to reduce this time, and secondly to give maximum utilization of keyboards.

Each publisher has its own style and normally the keyboard operator has to build this style into the author's manuscript. The main difficulty is to achieve uniformity especially when the copy may arrive in several batches or be distributed among a number of keyboard operators. Furthermore, the copy may not always be completely legible and with complicated work a large amount of time is spent by the keyboard operator in checking queries. These are additional reasons for the copy preparation which has been instituted in several firms.

Some firms (of about the same size and character) may spend several thousand pounds a year on copy preparation, others may use only the part-time services of a single reader; some do no copy preparation at all. No information could be obtained on the material advantages and economics of such departments although one firm had discontinued copy preparation because they believed it to be uneconomic (no further details were available). The extent of copy preparation, both as to type of work prepared, and degree of preparation, also varies. One firm, oddly enough, prepares only its straightforward bookwork; though it appeared to the team that other types of work at this firm presented more difficulties and would have warranted better preparative treatment.

In general, the object is to correct the copy before it gets to the keyboards. Some firms favour typing fresh copy when corrections are heavy, but others insist that this inevitably leads to further errors. In addition to providing good copy for the keyboards, copy prepara-

tion can also provide information on special sorts that will be required and in this and other ways help to ensure that the production schedule is maintained.

As for the keyboard department itself, this is frequently under the broad control of the composing room overseer. In a few cases the work of each operator is planned and the flow of work is fairly straightforward. By contrast, in some firms, copy comes into the keyboard department from several sections of the composing room, each piece of copy as 'urgent' as the other, and the keyboard overseer is left to sort out the muddle. Most firms could benefit by examination of their work-flow procedure at this point.

MONOTYPE CASTERS

The work of this department is dependent on the keyboards. However it was noted that communications between these two sections were often the poorest in the works. Formal communication depends solely on passing over the keyboard paper, together with details of any die-case changes. In the absence of any rigorous planning, as is usually the case, there is no doubt that informal communications play an important part in reducing the number of machine changes to be made. Generally when communication is deficient, it is this informal contact that is lacking. Such a situation arises partly from the difference between the two classes of operators: the keyboard operator's task is essentially one requiring mental concentration, and the caster operator requires mechanical ability. Both are skilled men but because of this difference in their work there are also differences in dress, personality and, in some cases, remuneration (particularly in firms operating a bonus incentive scheme). These differences have an adverse effect on informal contact and co-operation. It is not possible to force informal communication and the answer to the problem is the establishment of a procedure which is independent of personalities for passing information between departments.

An individual job may contain several type faces and, with corrections, type made on several different occasions and machines. Consistently good quality type is essential in order to minimize makeready at the printing machine. One cause of increased makeready occurs when sorts casting for corrections is not given the same attention as composition casting; the former is very often carried out on the oldest machines with worn moulds, so producing type below the standard height. Most firms are aware of the need for accuracy in type height and have introduced various inspection procedures. Some of these schemes are very elaborate but give results no better than those from much simpler schemes; other schemes are in fact used in a way that bears little resemblance to the procedure laid down and become consequently little better than useless. It does not require much effort to maintain accuracy of type height; moulds

and matrices wear very slowly and the new hard-faced moulds should further simplify the problem. At the present time the main emphasis is on checking the body height of type (as a check on mould wear) with little attention being given to other attributes of type quality such as matrix wear and correct width and alignment.

Other factors influencing the quality of the type include the composition of the metal, the temperature at which it is maintained, the speed of casting, and the condition of the casting machine. Again many firms do not pay sufficient attention to such factors. Quite small differences in type quality have considerable effect on makeready time and on final print quality.

COMPOSING ROOM

The operations performed on the cast type before it reaches machines vary with the type of work. The treatment of the type, however, leaves a lot to be desired. One instance is galley proofing, which is frequently left to apprentices. The proof presses are generally very ancient, and, with galleys of varying thickness, it is usual for excessive pressure to be applied to the type during proofing. Since proofing is carried out at several stages, the repetition of this procedure must adversely affect the quality of the type face. Another point is that the accuracy of justification of the cast type is partly destroyed when corrections are made, since unless the corrections are heavy the compositor does not normally use a composing stick. It is far more usual to correct the line while it is lying in the galley, and no real attempt is made to justify the line except by touch, running the finger or the tweezers along the side of the lines of type to detect any depression or projection. Thus when furniture is put round the pages in the chase the lines of type are not all compressed in the same way and this can result in rising spaces and other troubles on the machine.

It has already been mentioned in Part III how the compositor puts a great deal of time and effort into registering a forme. The equipment he uses for this purpose is not however conducive to accuracy. Ideally to line up the heads of pages a straight edge is required but many compositors rely on gauging by eye or using a flexible steel rule as a straight edge. Folding carpenter's rules are another common piece of equipment. That such procedures can give an accuracy of better than a fiftieth of an inch, which is often needed at machine, requires a stretch of the imagination. In any event, too often the accuracy is lost by the time the forme reaches the machine, through the combination of poor furniture and chases with excessive lock up pressure; and the machine minder must repeat some of the work of registration. These difficulties can be overcome and in a few firms they are overcome by the use of good materials, proper equipment, and an adequate procedure for handling the formes.

The initial cost of upgrading the quality of type, chases and handling equipment is very high, especially for a bookwork printer who has

a slow turn round of work, but the changeover can take place gradually. A useful, although not necessarily essential, piece of equipment is a lining-up table. This provides a flat base, a straight edge, a means of accurate measurement of depth and width, and provision for graduated scales for standard sizes. Such equipment was used to good effect in only one of the firms investigated. Other firms have such tables but the operators have never been taught to use them correctly and the materials and transporting requirements are often not met. Consequently, as too often happens with such equipment, due to these shortcomings in operation rather than to any defect in the equipment itself, they fail to be effective and fall into disuse.

Methods and procedures adopted are to some extent dictated by layout of work space. Spatially, and otherwise, the composing department, with its related sections, is an important one. In the firms studied an average of 20 per cent of work space is taken up by this department, the proportion varying from 8 to 40 per cent for individual firms. How the average firm uses this area is shown in Fig. IV.1.

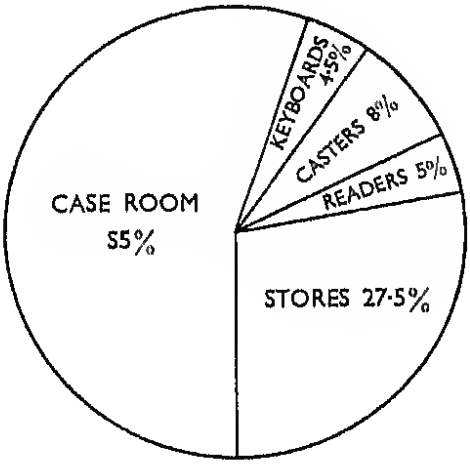

Fig. IV.1. Utilization of composing room area

It is seen that the case room occupies only 55 per cent of the space and has just twice the area devoted to stores. Each firm has separate stores for major items such as type formes, duplicate plates, blocks, sorts and furniture. The bookwork printer is the worst off in this respect and a third of his composing room area is devoted to stores. This is, of course, largely accounted for by the amount of standing type this work necessitates. These storage figures exclude any area of the case room which is taken up by storage of work in progress and by such items as type cases, furniture and other materials in regular use.

The tendency of printing firms is to sectionalize composing rooms, not only as regards type of work, (as jobbing, magazine, bookwork), but even further into groups on particular journals, etc. This results in unnecessary duplication of equipment and materials as well as difficulties in adequate disposition of the labour force when there is

a fluctuating demand on each section. The flow of work in a composing room can be carried out as a straight line process, i.e. corrections – make-up – imposition. Although a few firms have adopted some degree of specialization in the work of their compositors the remainder have compositors that look after complete jobs. While there are disadvantages to the individual (i.e. routine working) there is no doubt that a flow-line principle would be better from the production point of view. Not only would it save a great deal of walking about by having the appropriate stores and equipment at the relevant points of the process, but savings in space and materials would result from the improved layout. A further advantage of straight-work flow is that it would facilitate transport of work even in those firms where the construction of the building necessitates having the composing room on several floors and in numerous rooms. Instead of having to provide wide gangways and large lifts from all parts of the department these would only be necessary from the imposition section to the machine room. Development along the lines of modern production methods should be very profitable even though it does require some major changes.

Firms with little or no work planning depend on good relations between composing and machine departments. Without such relations or planning the compositors do not know which machines the various jobs are going on and the machine room cannot plan its work to the best advantage (see also Part II, Section 3). Even though internal telephones may be provided it still appears that distance is the vital factor. Certainly the closest co-operation noted between machine and composing room overseers was in the firm which placed their offices together with a communicating door. This is also useful for the production office when discussing a particular job; between the three of them they can arrive at some plan of mutual advantage very quickly. Good communication becomes very important when the machine room is keeping pace with the output of the composing room.

PRE-MAKEREADY

From the point of view of organization this is a rather complicated section involving mainly the composing, foundry and machine departments. It is also a comparatively young section. The combination of these factors results in the fact that it was often not the complete responsibility of any single departmental overseer. Doubtless this lack of a senior man with real responsibility accounts for the shortcomings that often exist in this department.

The object of pre-makeready is to prepare the printing surface, whether type, plates or blocks, as far as is economic before it gets to machine. Most firms admit the uneconomic nature of the department but this failure is due to the work it carries out. Mostly it is used solely for mounting and re-mounting blocks and the preparation

of mechanical overlays. Some even remount blocks on wood as they arrive in the works but by the time these eventually reach machine the bases have again distorted and have to be taken back to the foundry for planing; this is certainly not conducive to economic working.

Where metal mounting is employed blocks may be interlayed beforehand. In some firms all blocks are mounted to 0·918 in. irrespective of subject or weight of screen; others make allowances for the amount of solids or highlights in the block.

The quality of the mechanical overlays prepared depends on several factors and there are many cases where the results leave something to be desired. Deficiencies in the overlays, as in block mounting, destroy the aim of the section and the results are readily noticeable at the machine: minders taking blocks back to the foundry, interlaying and underlaying blocks, rubbing out the highlights of the mechanical overlays, refusing to use the overlays at all, patching over the top of them, and so on. Once more the machine minder has to make good deficiencies in earlier methods.

Only one firm is justified in calling its department pre-makeready in the full sense of the word. Apart from preparing mechanical overlays and mounting blocks it also brings duplicate plates up to standard height, pre-registers formes where necessary, takes a proof for revise and has the corrections carried out on the forme before it gets to the machine.

Finally, there were a large number of complaints concerning the quality of original and duplicate plates. There were complaints concerning poor depth of etch of originals and misleading pulls sent with them. Others concerned variation in thickness of originals even over a single plate. Furthermore because of the lack of standardization of the height of original and duplicate plates the printer often has the task of mounting plates of several different heights in the same forme, especially in jobbing and magazine work. To complicate the matter a little more, blockmakers and foundrymen usually measure in inches whilst the printer measures in points. All these items do not help the printer to work efficiently. More control of quality is required in the blockmaking process, while standardization of thickness and size calls for greater co-operation between printers and blockmakers.

FOUNDRY

Apart from duties towards pre-makeready discussed above, the foundries visited are mainly concerned with making and correcting duplicate plates. In the whole field of foundry-work there have been a number of important developments in recent years. Some of these relate to duplicate plate-making, new types of flong materials to save packing in on stereotyping, plastic matrices and silver spray deposition

in electrotyping, and an increased range of polymers for rubber and plastic plates. In keeping with these developments many foundries have been modernized, as far as machinery is concerned, in order to improve precision. Those still relying on old machines cannot guarantee a planing accuracy of better than five thousandths of an inch, whereas new machines improve on this by a factor of ten. The consequences of the two levels of accuracy at the printing stage are obvious.

Production of metal duplicate plates seems to have decreased in recent years and this appears to be due to certain long-run work being now carried out by rotary machines. The most common types of flatbed work that are plated nowadays are Bibles and text-books which are unlikely to need heavy corrections on reprinting. Plates are normally only made for long-run work but some firms find it advantageous to print short-run work from them (i.e. from 2500 runs upwards) especially if there is a possibility of a reprint. The advantages of plates are that they are easier and faster to impose than type pages, easier to handle when imposed, they maintain a better quality over a long run, and are far less bulky and much lighter to store.

To maintain plates in good condition means mounting them on a flat base and many of the old wooden bases in use are far below the standard required. This means that after even a single run the make-ready time increases considerably and after several runs the desired quality of work cannot be achieved. Some firms makeready at a financial loss on such plates in an endeavour to please the publisher. The latter was probably told that nickel-faced stereos would give 150 000 copies but with the handling they have received less than half of this has been run before they are worn out. Even with good technique plates do not last for ever but publishers rarely consent to a job being reset. Some plates dating back to the last century are still regularly printed from with the natural consequence of long makeready time. For some jobs publishers do not give instructions for plating until after the first printing from type. This allows them to assess future demand as well as to make any corrections cheaply. The type is then however a mixture of new and old, the latter being somewhat worn, which will not produce plates of good quality.

The majority of rubber and plastic plates being produced by the firms investigated were for rotary letterpress printing, but a few were for flatbed work. The surprising feature about the preparation of these polymer plates is the variation in methods of production even when using the same materials. The existence of variation in other printing operations is understandable owing to the secrecy prevailing between firms years ago which led each firm to develop its individual technique. Flexible plates however, are a recent development in the firms considered and there is far more co-operation within industry nowadays. The final plate is apparently the same by each method but due to differences in the procedure adopted the productive speed in

one firm is over twice that in another. There seems to be no reason for not adopting standard procedures for processes such as this.

The foundry relies mainly on the composing room for its basic materials, i.e. imposed type-matter. Problems of registering formes of type do not occur as in the first place a maximum of eight pages are imposed and secondly plates are invariably cut into single pages after casting. Some of the larger firms have a foundry imposition department, while in others the foundry is frequently kept waiting while a compositor is freed from some other work. When the size of firm does not permit workers to be exclusively employed on pre-makeready this often becomes an ancillary function of the foundry and men are not available as required. This may lead to delays, requiring attention in the firms concerned.

WAREHOUSING

This covers both white and printed paper storage and handling. The area of the works taken up by such storage is about 30 per cent, being rather more for bookwork printers and rather less for others. White paper storage is a burden to all printers and much of the stock arrives several months before it is required at machine. This is not so true of magazine and jobbing printing. The basic reason is the time taken between commencing a job and its printing, which in the case of some technical books may even be a matter of years. The publisher orders the paper at about the same time as he gives the work to the printer and when the printer receives the paper he has to store it until required. In contrast, work which has to be printed rapidly, as in much jobbing work, instances have been seen where the forme has reached the machine and the paper has not yet arrived. A general improvement in efficiency in the industry combined with closer co-operation from publishers will mean that paper stocks will be considerably reduced at any one time. The alternative is to devise a satisfactory scheme for receiving paper nearer to the time it is required. The unnecessarily large stocks held at present add to the overheads charged to jobs. Other consequences are the space involved which could be better used by productive departments and the high capital cost involved in improving handling methods, such as palletization.

The white paper department may be the responsibility of a separate overseer but frequently it comes under the control of the machine room overseer or of the printed paper and despatch overseer. Little attention is given to the organization of the white paper department. Usually when the machine room overseer receives the printing instructions for a job he has to requisition the paper from the warehouse. In such cases it frequently happens that the warehouse has only short notice; if the paper has to be cut and lorries

unloaded at the same time delays to machines occur, particularly in the smaller firms where only a few people are employed on this work. Other delays to the printing machines occur; for example, in the firm that recruits labour from the machine room to unload lorries, and also in the firm which relies on the bindery to cut white paper. There is no reason for not informing the warehouse at the first opportunity of the paper required for the machine room so allowing the paper to be prepared at convenient times. Cases where jobs get to the machine and the paper is not even in the firm have already been mentioned. Such examples stress the need for greater inter-departmental communication, in particular, between the office and various departments.

Printed paper warehouses are again largely a store for publishers. A firm may print a job of say 20 000 copies but only 5000 of these may be required for immediate binding. The firm either binds these itself or sends them away in flat sheets or folded sections to an outside bindery. The remaining 15 000 are held in stock until required. While most of the stock gets used in time, there is usually a proportion which has remained for many years (even 30 or more years); in some cases this has yellowed with age and it is extremely doubtful if it would ever be used. Again this is only adding to the overall costs. Some firms claim that it is advantageous to fold all sheets before going into store as this saves resetting time on the folding machine when the next binding order is received. The advantage of this procedure depends largely on the storage facilities available.

The relative ease of handling of palletized loads contrasts with the lack of accessibility in confined spaces and the manhandling of individual reams stacked on the floor. Many firms have some form of fork-lift truck, mainly as a means of utilizing more easily the full ceiling height of warehouses. These mechanical aids, however, are seldom fully utilized, their use being confined to the warehouse because of the congested layout elsewhere. There is nevertheless a great need for mechanical handling throughout a printing firm. From the time the paper enters the firm to the time it is ready to go to the bindery it may have to be handled a dozen times; the average machine (of the types considered in the survey) uses about a ton per single shift week and so, with repeated handling, a very large effective tonnage is involved. There are a number of other problems to be considered in relation to paper handling; of these the most important is the cost of palletization with a slow turn round of stock, and the fact that machines must at present be loaded by hand. The requirements of individual firms vary a great deal and it cannot be suggested that each firm should have certain equipment or adopt certain methods because these may not be justified on an economic basis. A thorough review of paper storage and handling is nevertheless desirable in most firms.

Nine of the firms visited do little or no case binding, and their warehousing activities are confined to magazine stitching and perhaps paper backing. One of these firms operates in an old two-storey building in very cramped conditions, and little effort has been made to utilize the space to the best advantage. Sections are folded on the lower floor, transported upstairs for gathering, sewing and glueing, and then downstairs again for trimming. The eight other firms of this group have ground floor warehouses with no space difficulties. In two of these firms production flow lines have been installed for paper-back work; one line uses hand work almost entirely, whilst the other is mechanized in gathering and wrappering. In the remaining six firms the machines are set out with no particular flow in mind. The type of work dealt with varies from week to week, and the operatives are required to adjust their jobs to the work going through. Under these circumstances it is difficult to formulate a flow line that is universally useful. Of the binderies proper, five are on the ground floor only, the others being on two or more floors. In all these the layout appears to be the result of gradual growth, without overall plan. Broadly speaking, the folders are grouped together, the gatherers form another group, and the sewing machines a third. Case-making machines are often isolated, perhaps even in a different room; three-knife trimmers are not usually adjacent either to the sewers or to the unsewn binding machines. This system of grouping leads to continuous transport of sheets, sections and books about the bindery, and a general air of confusion.

The siting of the individual machines does not normally affect their operation, but the positioning of a gatherer-stitcher can have a marked effect on its operation. The L-shape of this machine suggests locating it with the long arm against a wall, the short arm at right angles to the wall or in a corner, with the operators feeding the machine sitting within the angle. This leads to an awkward feeding motion, quite different from that appropriate to other machines, or to feeding while facing away from the on-coming work. The logical right-handed method of feeding requires the operators to sit on the other side of the main arm; this would appear to require more space for the machine. A better solution would be a re-design of the machine to an inverted L-shape so that right-handed feeding could take place with the operators sitting within the angle and facing the oncoming work.

Furthermore, in some firms these machines are only running for short periods and are operated by girls recruited from other work who are not very proficient at feeding. This cannot be avoided, but it is possible to run the machine at a speed which will allow the girls to feed the machine continuously. Very often the machine is running at top speed and misfeeds cause frequent stoppages, whereas a lower speed would allow a rhythm of feeding to be developed which would

be far more productive. The same consideration of speed applies to other machines, particularly certain types of sewers where there is no speed control and the operator consequently feeds with a stop-go motion. Again a slightly lower speed would enable the operator to keep the machine running continuously with more production and less fatigue as a result.

Part V. Problems Requiring Further Study

Summary

This investigation, which has been primarily concerned with productivity, has highlighted the various problems requiring solution for improvement of efficiency. Such problems are of an industrial engineering nature rather than purely technological. In particular, the examination of the whole procedure for producing print in a firm is more important than the study of individual methods, although the latter should not be neglected. Other items discussed include control of manufacture, design of machinery and equipment, and the need for some degree of standardization, and for the reduction of corrections to type. Finally, technological problems are considered and the findings mainly confirm that the items at present studied by PATRA in this field are those of greatest importance to the industry.

1. OPERATIONAL RESEARCH AND KINDRED STUDIES

Operational research can be briefly defined as a scientific method of providing management with quantitative data on which to base their decisions, thereby making the optimum use of men, machines, material and money. The discussion of actual problems below will provide a clearer indication of how the technique works than would any formal definition. Further information on operational research techniques can be obtained from the references listed in Appendix B.

METHOD STUDY

Extremely slowly the printing industry is becoming aware of the need for method study and even more slowly it is taking appropriate action. The present survey shows that there is a great need for such action since in each firm there is sufficient work to warrant at least one method study officer per hundred employees. Individual operations, materials handling, work flow, and so on, would all benefit from method study. At the same time there is the need for the operational research approach. The printing process is so complex that method study alone cannot achieve optimum production. Very often a change in method in one department cannot be effected without changing methods in other departments. Method study of the patching of overlays, for example, can do little other than to

ensure that the machine minder has the right equipment and materials available at the right time. Operational research would examine the problem as a whole; this would mean studying relevant procedures right from the time the copy entered the firm – and perhaps at the even earlier stage before it leaves the publisher. The final solution would involve questions of economics and policy and the model of the situation would undoubtedly require detailed analysis, both statistical and otherwise.

One difficulty that has been mentioned in the report is the lack of information in a firm on which to base decisions. Another is the natural resistance to new concepts of production, particularly in the printing industry where some methods have remained virtually unchanged from their inception. Operational research would provide the necessary quantitative data on time, efficiency and cost and compare present procedures with other possible ways. The introduction of scientists, and other 'outsiders' into printing works would throw new light on procedures; this cannot be done by method study alone, especially since these method study officers are often printers trained in some of the elementary principles of methods technique.

CONTROL SCHEMES

Control schemes are based on the pattern of behaviour existing in a process and are designed to provide information in sufficient time to allow for the most economic action to be taken.

Such schemes are difficult to construct when there are a large number of random influences, for example, with production control in printing. The need for production control has been stressed since only by this means can an orderly flow of work between and within departments be achieved. Some firms say that a planning or control scheme would be pointless because the customer will not return proofs on time, or because 90 per cent of the work is rush work, but these random influences involve just those questions of choice or chance which are the particular sphere of statistical technique. In this respect operational research can be of value and whilst complete control may be impossible an analysis of the situation will provide an improved system.

As regards stock control, elaborate schemes are out of place in most of the firms studied. The printer's own control of stock is limited since customers frequently buy the paper and decide for what period type, plates and blocks must be held standing. The control of stocks may be of greater value to publisher-printers and others who buy their own materials. The problem of storage should repay further investigation, however, since on average about 30 per cent of the floor space of the works is taken up by white and printed paper alone.

Finally, quality control schemes may be of value in larger firms, particularly as regards raw materials; there appears to be most scope

for such schemes in the printing of long-run work (cartons, etc.) and in paper converting. Whether or not a quality-control scheme is economically justifiable depends entirely on the circumstances in each individual firm.

ENGINEERING

Many of the problems classified under this heading concern the design of machines; in almost every instance a detailed scientific study of the requirements would be necessary before a new design could be produced. Substantial improvements in productivity and quality can often be achieved by quite small changes in machine design. The basic principle is to design machinery to suit the operator as well as to perform the work required; this field of study is known as ergonomics.

On the printing machine, for instance, the minder is stationed at the delivery end while the machine is running, in order to keep a check on the quality of work being produced. From this point, however, he has no control over the machine, apart from being able to stop it. To alter speed he has to go round to a position near the main electrical unit. Similarly, to adjust the ink flow he must crouch below the bed of the machine at the back and then move to the delivery end again to see the effect of the change made. Many adjustments, such as to the feeder, are made by unlocking a nut or bolt, sliding, and re-locking the nut or bolt. Apart from considerations of accessibility of such controls, the nature of the adjustment mechanism often requires stopping the machine. Accurate adjustment may be impracticable in such circumstances when it must be made by tapping with a spanner on the slightly loosened nut or bolt. Further, many machines have no indicators for speed or other adjustments, and a procedure of 'moving it a bit' is adopted rather than adjusting by some calibrated amount.

In the composing room most of the accurate registering equipment available, such as lining-up tables and optical devices, is prone to large errors due to parallax. The measuring scales provided on lining-up equipment usually require the reading of a Vernier and operations of addition and subtraction, and so these scales are almost never used. This is only partly a question of design; equally important is the need for training operators in the correct use of the equipment.

The need for designing printing machines which will facilitate makeready has already been mentioned in Part II, and in Part IV the need for improvement in certain binding machinery has been indicated. In bindery work there is an increasing tendency to adopt orderly work flow principles, and this has been encouraged by new machines combining operations previously carried out by several separate machines. The development of full automation in this field is a practical possibility. In smaller firms fully automatic plant is not

economically justified, but many will still wish to bind their own work. These can still adopt flow principles using conveyors to link units, but the great drawback at present is in the different speeds at which the various units in the line can operate. This poses further engineering problems.

MISCELLANEOUS

One of the limiting factors in the overall efficiency of firms is the lack of standardization. Inter-firm comparisons do not show the effect of this since it affects all firms to more or less the same extent. One firm, for example, has 27 different book page sizes within the range 5 in. × 7 in. to 5½ in. × 8 in. If page length and width are varied independently in ⅛-in. steps, there are only 45 possible combiuations; no doubt the missing combinations are covered by other firms. In fact some sizes vary from another by only a sixteenth of an inch in one direction. This same firm has in current production 116 different page sizes, almost half of this number falling between 4½ in. × 6½ in. and 6½ in. × 8½ in. This is a fair-sized firm with 89 compositors. Another firm with only 31 compositors currently has to produce fifteen different 'demy octavo' page sizes. Some effects of this lack of standardization are immediately obvious; the composing room needs to have enormous stocks of different sizes of furniture and is constantly cutting up leads and so on to size; production planning becomes increasingly difficult; both printing and warehousing machinery is constantly being adjusted, and storage of the ridiculous multiplicity of sizes raises further difficulties. Absolute uniformity is not suggested but such variety cannot be serving any useful purpose. This lack of uniformity, and particularly the influence it has on cost, urgently needs investigation. Such an investigation could form the basis for useful consultation between printer and customer.

There are several other problems of standardization related to printing which also deserve attention.

One would like to know how the cost of printing is determined by the quality level aimed at. Some aspects of quality are not easy to measure, however, and there may be difficulties in recommending action on quantitative lines.

There is also a need for an investigation into corrections to type. It has been noted from the records available that about 40 per cent of compositors' time is spent in making corrections. About half of this 40 per cent is recorded as authors' corrections and half as house corrections. It is obviously important to investigate further to find the detailed reasons for corrections together with ways in which they can be eliminated or reduced.

Solution of the problems outlined above would benefit not only flatbed letterpress printing but also the printing industry as a whole. The investigation of many of them would no doubt identify further urgent problems calling for both industrial and technological

research. There are, of course, other industrial problems many of which have been mentioned in the various parts of the report; for example, organization, communication, labour turnover, maintenance and so on. These, however, like many of the methods and control problems, require study in individual firms due to the variation that exists from firm to firm. Eventually such individual studies would allow general principles to be proposed.

2. TECHNOLOGICAL PROBLEMS

One of the aims of the investigation was to identify the main technological problems calling for research and so to assist in the formulation of PATRA's research programme. The investigation was, however, concerned with productivity and very few problems of a purely technological nature with any serious effect on productivity came to light. Some, such as rising spaces, were at times very serious on particular jobs, but in general the effect on production is very small. Printers consider that paper and ink properties are main items for technological research, but these, in our observations, more readily affect quality and have little effect on productivity. There was only one job, out of the thousands seen during the survey, that had to be repeated because of poor quality, but there were many where the printer was dissatisfied with the results. Poor quality affects the goodwill between printer and customer, and herein lies the importance of research in this field. Such lines of research are continuously pursued by PATRA and others.

The type of cylinder packing and related problems have an effect on the makeready time, so the properties required in cylinder packings need to be known. Other items have also been noted, for example, ink rolling of blocks to produce good solids, and the cleaning of blocks, type and rollers. Again all these problems are already being actively investigated.

PATRA is, however, not limited to technological studies only. It is the appropriate organization for applying science in general to the printing industry, and so problems outlined in Section 1 above also call for research by PATRA.

Part VI. Summary of Report

The organization, methods and production of seventeen firms producing flat-bed letterpress work have been studied in detail. In presenting the resulting information the main emphasis has been on defining the problems which affect the industry as a whole. By showing that the problems exist and indicating the ways in which they can be overcome, the investigation should encourage firms to examine their own particular organization, methods and procedures at the points mentioned in the report.

One of the fundamental needs of printing firms is for more information. Because of deficiencies here, even when firms are aware of problems they do not realize their full effect in terms of cost and production. They have no way of knowing quantitatively what the effects of taking a certain course of action will be and decisions are often based on the qualitative experience of others rather than on quantitative facts. The incentive bonus schemes in some firms do provide a considerable source of information about production, but in all firms the problem of collecting the right information and making proper use of it has to be considered. The first Part of this report deals with the measurement of productivity and with some of the factors which affect efficiency. There are several points in this Part which illustrate further the need for more information.

A detailed breakdown of machine time was obtained during the investigation and it was found that, on average, machines are only running for about 40 per cent of their manned time. With such a low running proportion, speed is not of prime importance. The circumstances are such that in most cases it is easier to increase production by reducing delays, makeready times and other stoppages. New machines have a high potential running speed but with short-run work and other limitations their average speed is little better than that of pre-war machines. What is required in printing machines at the present time is the provision of devices to facilitate makeready, control and adjustment.

In Part II the various factors responsible for the low running time of machines are discussed. While in some firms particular operations are inefficient, the greatest improvement can only result from a thorough examination of the printing process as a whole. The broad aim of every firm should be to ensure that before the forme is placed

on the machine it is as perfect as possible, subject to economic considerations. Precision is fundamental to printing, but several instances are reported where precision at one stage is destroyed in subsequent operations and the loss has to be rectified as far as possible at the machine. Most firms could make substantial improvements in methods and procedures with very little capital outlay, but few have any person in the firm available to undertake the work. The changes in methods will, however, often require a change in outlook and to secure and retain efficiency an industrial engineering approach is required using work flow principles: greater specialization of work by employees; quantitative measurement rather than 'instinct' or 'experience'; mechanical aids for handling; and so on.

As well as methods, the report also discusses matters such as organization, production planning and storage. Here again some major revisions in procedures are required. In the case of organization not only should the system be designed to provide the necessary information for efficient running of the firm, but there is a need for better downward communication and control. The organization was found to be particularly weak in the links between departments. Inter-departmental communication is of great importance in printing owing to the dependence of one department on another. While some firms have achieved a successful production planning system, generally on a limited scale, others wrongly feel that it is not applicable to their work. The need here is for production planning systems designed to take account of various random influences that prevail. The benefits of production planning are well known and the disadvantages of not having such a system are frequently brought out in various sections of this report.

Printing is largely a bespoke trade, and as such not all factors influencing efficiency are within the printers' immediate control. In production planning, for example, one of the greatest difficulties is the delay by customers in returning proofs, particularly in book-work. The customer also determines the stocks of standing type and plates, and of white and printed paper. About 30 per cent of the composing department's area is taken up by storage, largely for customers, whilst paper storage occupies 30 per cent of the entire floor area of the works. Space costs money and someone has to pay for the unnecessarily long time materials are often kept in store.

There are also several problems of standardization concerning, in particular, the height of printing plates and blocks, the units of measurement used by blockmakers and printers, and the page sizes of books and journals. Some variety in the latter is necessary, but there can be no value in having the pages of one book differing from those of another book by only an eighth or a sixteenth of an inch in a single direction. Lack of standardization necessitates large stocks of basic materials, causes difficulties in planning and lengthens the time required to produce the job; all of this adds to the costs. These are some of the problems discussed which call for greater

co-operative effort between printers and other sectors of the industry.

The points mentioned above are just a selection of the many mentioned in the report and serve to emphasize the need for improvements in various parts of the industry. It may seem to the reader that the report presents a gloomy view of the industry, but that is not its intention; there are good points but space does not permit their inclusion. There is not, however, any room for complacency as any printer who examines the problems will find out for himself.

Appendix A

Information Sought from Firms on Productivity

*1. Number and size of sheets printed.
2. Machines used for (1).
3. Details of machines: age, size, horse-power, etc.
4. Hours worked to produce (1).
*5. Total paper used.
*6. Fuel and power used.
7. Types of work.
8. Analysis of jobs in terms of length of run, etc.
9. Nature of bonus schemes in operation.
*10. Number of pages made up and formes imposed.
*11. Production of typecasting machines.
*12. Number of sections sewn.
*13. Number of books bound, of various types.
14. Areas of departments.
15. Personnel records; breakdown of staff employed, labour turnover, etc.
*16. Number of duplicate plates made.
17. Number of pages of type in store.
18. Number of duplicate plates in store.
19. Value or rent of buildings.
20. B.F.M.P. book production returns.
21. Board of Trade Census of Production returns, 1954–1957, inclusive.
22. Ministry of Labour returns.
23. Breakdown of time spent by machines or men in departments.
24. Chart showing organization of firm.
25. Controls kept by firms running an incentive bonus scheme.

* These production records were obtained for a specific period, i.e. 3 months, a year, etc.

Appendix B

Scientific Terms

1. MULTIPLE REGRESSION ANALYSIS

The method used for multiple regression analysis in computing the 'Index of Technical Efficiency', (page 5 *et seq.*) is given by B. Woolf, 'Computation and Interpretation of Multiple Regressions': *Journal of the Royal Statistical Society, Series B*, 1951, XIII, 100–119.

The methods described by Woolf in his paper are easy to follow and can be expeditiously carried out on a calculating machine. The analysis proceeds by successive insertion of additional variates. This was a great advantage in the present case where it was necessary to test the significance of eleven variables. After a variate had been added to the calculation matrix the resulting regression coefficients could be tested for significance. If a variate was found to be non-significant it could readily be removed without destroying the major part of the matrix (which was composed of factors previously found to be significant).

The regression equation with four independent variables is given by:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4$$

where a is the value y would have if x_1, x_2, x_3, and x_4 were held constant at their mean values,

and, b_1 measures the rate of increase of y with increasing x_1, with x_2, x_3 and x_4 held constant at their mean values. Similarly for b_2, b_3 and b_4.

The b's are thus 'partial' regression coefficients which take into account correlations between independent variables.

From the equation (see page 6), –

$$Y = 4{\cdot}15X_1 + 2{\cdot}46X_2 - 1{\cdot}47X_3 + 1{\cdot}26X_4 - 88$$

the number of impressions expected from each of the firms can be calculated by substituting their particular values of X_1, X_2, X_3, and X_4. The Index of Technical Efficiency is then given by

$$\frac{\text{Actual Number of Impressions Produced}}{\text{Expected Number of Impressions}} \times 100$$

2. STATISTICAL SIGNIFICANCE

In several parts of the report two means have been compared. In doing so the variation that exists in the two samples has to be considered, i.e., is the variation within the two samples so great that the two means could have been obtained by chance. Where a difference in the report is stated to be

statistically significant then it is unlikely (less than a 1 in 20 chance) that both samples could have arisen by fluctuations in random sampling. It can then be inferred that the two sample means are estimates of the means of two different populations.

This particular test is known as Students' t-Test and details of its method of calculation, etc., can be found in most statistical text-books.

3. ACTIVITY SAMPLING

The technique was originally developed by L. H. C. Tippett of The British Cotton Industries Research Association and is described in his paper 'Statistical Methods in Textile Research. Uses of the Binomial and Poisson Distribution. A Snap-reading Method of Making Time Studies of Machines and Operatives in Factory Surveys'. *Journal of Textile Institute, Transactions*, vol. 26, pp. 51–55, Feb. 1935.

Whole books have now been written on the subject including *Work Sampling* by R. E. Heiland and W. J. Richardson, McGraw-Hill, 1957.

There are also several excellent 16-mm sound films explaining the technique, for example, *Introduction to Work Sampling* which is a colour film running for 19 min. made by University of California (available from Central Film Library, catalogue no. V470).

4. OPERATIONAL RESEARCH

There are no articles giving operational research case studies specific to printing although there have been a few giving probable applications to printing and allied industries.

The two volumes of *Operations Research for Management* edited by J. F. McCloskey and F. N. Trefethen, The John Hopkins Press, Baltimore, 1956, contain a number of general articles suitable for introductory reading. A further suggestion is *Introduction to Operations Research* by Ackoff, Arnoff and Churchman. New York: John Wiley, 1957.

Two papers published in the *Operational Research Quarterly* should also be useful as an introduction to the scope and nature of operational research. These are:

'What has Cybernetics to do with Operational Research?' by S. Beer, March 1959 issue; and 'Operational Research To-day and To-morrow' by A. W. Swan, Dec. 1958 issue.